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THE CONTINUED INTRAVENOUS "DRIP"[*]

WITH REMARKS ON THE VALUE OF CONTINUED GASTRIC DRAINAGE AND IRRIGATION BY NASAL INTUBATION WITH A GASTRODUODENAL TUBE (JUTTE) IN SURGICAL PRACTICE

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1. THE purpose and gist of this communication is to direct attention to the value and advantages of the intravenous route for the direct and *continnous instillation* of fluids intended to replace the volume of lost blood and for infusing stimulating, nutrient and medicated solutions in shocked, toxic, exhausted and dehydrated surgical subjects in whom the usual indirect avenues of the circulation and the tissues are either unavailable, insufficient or inefficient when there is urgent need of a prolonged prop to the circulation in the great emergencies or crises of surgical practice.

2. By the intravenous " drip " is meant the direct administration of artificial sera (replacing, nutrient and medicated) drop by drop, into a selected vein for such variable periods of time (usually from one to six days and over) as may be required to restore the vascular equilibrium and rally the patient until the defensive cardiovascular mechanism has had time to assert itself or it is evident that it has failed to respond to artificial aids.

3. The intravenous drip is not intended as a routine substitute for, but as a secondary measure to follow, the primary massive intravenous infusion of sera (saline or glucose solution) which, in profoundly shocked, exhausted and starved surgical patients, are more often temporary or ephemeral in their effects.

In many shocked patients, as we all know, the immediate restorative effect of a hot intravenous salt or glucose infusion is, for the time being, brilliant; but this effect is more often transitory, so much so that it suggests that the fluid injected has simply run out of the vessels into the tissues, just as if that much water had been poured into a sieve. Hence the efforts that have been made to hold the infused fluids in the circulation which we recognize in the introduction of the gum-salt solution of Bayliss, the gelatin of Hogan, etc., which tend to imitate plasma, rather than the serum of the blood, by increasing the viscosity of the injected fluid.

But even then dilution soon follows, and these solutions, which cannot be injected indefinitely, soon seep out of the vessels or accumulate in the

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reservoirs of the great splanchnic veins, leaving the arterial system empty, the peripheral capillary circuit stagnant and the patient as collapsed as before the infusion. The advantage of the constant drip lies in the steady stimulation with an isotonic oxygen and pabulum-carrying fluid which not only replaces the lost fluid for an indefinite time but stimulates and nourishes the heart muscles and brain centres continuously without overcrowding the heart. Thus the storing of energy in the cellular batteries is kept up and the metabolic processes continued, provided no permanent degenerating or necrogenic cellular changes in the vital territories of the master organs have already occurred, which would make them incapable of responding to any form of stimulation.

4. The value of the continuous intravenous drip is especially apparent in the post-operative treatment of septic abdominal cases in which dehydration and exhaustion caused by prolonged vomiting and fasting from mechanical obstruction or toxæmia, have preceded the operative act, and when the absorbent and eliminating functions, as well as the mobility of the gastro-intestinal tract, have been so paralyzed and inhibited that the usual avenues of supply by the oral, rectal, hypodermal or gastroduodenal route *via* the duodenal tube (Einhorn, Rehfuss, Jutte) or even the cholecyst-duodenal drip (McArthur, Matas) are blocked or unavailable.

5. Notable examples are: Intestinal obstruction and septic peritonitis from multiple perforating gunshot wounds of the abdomen, ruptured appendix, perforating gastric and duodenal ulcers, obstructed common duct with hepatic insufficiency, gangrenous gall-bladder, advanced pyloric obstruction from carcinoma or benign stricture, with marasmus from prolonged starvation, or after nephrectomy from pyonephrosis with threatened anuria. In many of these, and especially the delayed cases, operations have to be performed in which the primary focus of infection or an obstructive lesion is removed; but the patient is left profoundly shocked, toxic and exhausted, with empty arteries, a stagnant capillary and venous circulation, and with dry, dehydrated tissues dying of thirst and starvation.

6. Every surgeon of experience knows that in the particularly grave cases that we have in mind the rectal drip (proctoclysis), even when retained, is of little or no service; it is frequently not absorbed, especially when the portal circulation is stagnant, as in advanced peritonitis with marked tympanites, and it is frequently not retained or even tolerated, and therefore fails when it is most needed. Hypodermoclysis, which is most useful as a preliminary measure or during the operation, also fails when the capillary circulation is at a standstill or failing from shock after the operation. Subcutaneous absorption is then either so long delayed or suspended from capillary stasis that very little of the fluid is absorbed and remains in great œdematous collections under the skin. The same may be said of the gastric or duodenal drip administered through a small duodenal tube (Jutte) introduced through the nose into the stomach and allowed to remain *in situ*. When the intestinal tract is paralyzed and peristalsis is arrested or reversed (regurgitation of intestinal contents) the fluids introduced through the tube accumulate in the stomach and are not absorbed. When septic peritonitis, acute gastric dilatation or adynamic intes-

tinal paralysis complicate an operation for chronic obstructive jaundice or from other causes the fluids introduced into the duodenum *via* the gall-bladder (" McArthur drip ") or through a catheter introduced into the common duct (" Matas drip ") are regurgitated into the stomach and not absorbed even after all obstructions to the common duct have been removed.

7. In the presence of a collapsed, practically pulseless patient, when it is evident that none of the above-mentioned indirect methods of restoration is efficient or available, the first and prime indication is met by the prompt intra-venous infusion of a stimulating isotonic fluid capable of replacing the lost or displaced blood.

8. The transfusion of citrated or, preferably, whole blood is undoubtedly the most efficient restorative, but this is not always available in emergencies; nor is its immediate beneficial effect always sustained, nor can it be applied continuously for an indefinite time when, for any reason, the main avenues of fluid supply are blocked or inhibited, as in septic peritoneal intestinal stasis; nor is it necessary or essential that blood should be used in many cases when other provisional means of supplying the circulation with fluids are available. Suffice it to state that for the majority of the emergencies under consideration an artificial serum infused intravenously will meet the immediate indications by spurring the cardiovascular mechanism to renewed activity. This rally may be permanent and sufficient or it may be transitory. In either case the cannula is to remain in the vein until the issue is determined by the further course of events.

9. If after a primary massive intravenous infusion the patient relapses again into the collapsed state or it is evident that the circulation is failing, the infusion is renewed in the form of a continuous drip, by which the artificial serum is administered with precision and exact dosage at a rate varying, according to indications, from 40 to 60 drops per minute, or, roughly, an aver-age of 6 ounces per hour, or 140 to 150 ounces in the twenty-four hours (4500 to 5000 c.c.). In this way quantities varying from 4 to 5 litres of fluid or more, are infused directly, gradually and surely into the circulation in the twenty-four hours.

10. With increasing experience we have learned to rely prophylactically upon the intravenous drip in the very feeble, ill-nourished patients whose ability to survive an operation is doubtful. In these cases the intravenous drip is started with the operation and is continued *guttatim*, during and after the operation, as long as doubt exists as to the efficiency of the circulation. In these exceptional circumstances the intravenous drip is substituted with advantage for hypodermoclysis—the so-called " axillary sup," or for the rectal drip (proctoclysis)—since in the particularly feeble class of patients previously referred to, absorption is uncertain or likely to be long delayed.

11. The *duodenal tube as an adjunct to the continuous intravenous drip* is simply of priceless value. In the form of the Jutte tube, with its small bead-like tip (" sinker ") and numerous perforations at its rubber terminal end, it is easily introduced through the nose into the stomach with little difficulty. Once in the stomach, it is allowed to remain permanently *in situ*

and held to the nose externally by strips of adhesive plaster. There it is kept in place as long as the gastric contents are retained or intestinal peristalsis is reversed with regurgitation of the duodenal or jejunal secretions into the stomach. This is usually the case in all obstructive or paretic states of the bowels caused by septic peritonitis and other causes. Under these circumstances the necessary nutrient and artificial sera are regularly supplied by the intravenous drip while the duodenal tube is also at work emptying the stomach of the foul and constantly accumulating intestinal contents. The Jutte tube, as usually supplied by manufacturers, is long enough to hang over the side of the bed below the level of the patient to permit of constant drainage of the gastric fluids by syphonage, prompted by an ordinary glass "Triumph" syringe. The tube in this way acts as a drain for the fluids and allows of the continuous escape of gases which would otherwise accumulate in quantities in the stomach. When the stomach is empty the tube is hung up above the head of the patient and held attached to a post of the bed by adhesive plaster, leaving it open to allow the gases of the stomach to escape uninterruptedly as they accumulate.

By draining the stomach the gastric tube acts in reality as an artificial anus which empties the upper intestine of its toxic contents and diminishes the abdominal tension caused by the pent-up gases, thereby adding enormously to the comfort of the patient.

The Jutte tube passed through the nose does not interfere in the least with the voluntary, free and copious drinking by mouth of water or other pleasant, cool, refreshing drinks. The patient is thereby relieved not only of vomiting but of the intense thirst which is so distressing and peculiar to these patients. By using the tube as a syphon through the nose while the patient is drinking, the ingested fluids are immediately returned and the stomach is kept clean and the disgusting foulness of the intestinal contents is eliminated.[1]

12. *Gastric irrigation through a permanently attached Jutte tube as a refrigerant and antithermic agent.* When the fever is high the temperature may be lowered most effectively by allowing the patient to drink copiously of ice water by mouth, or the stomach may be alternately filled and emptied through the tube with ice water many times and for as long as may be required to obtain a reduction in the rectal temperature. The stomach then serves the purpose of an ice-bag, most conveniently placed under the heart, the liver and over the aorta and vena cava, where the blood circulating in the heart and the greatest central splanchnic area of the body can be cooled directly as it is sped by the heart to the most distant peripheral regions of the body. The stomach when cooled by a continuous or intermittent ice-water irrigation serves far more effectively as an antithermic agent than any ice-bag, sponging, towelings or other cooling methods applied externally. It is superior, under these circumstances, to the cold Kemp rectal irrigation and has the added advantage of keeping the stomach clean while the patient is refreshed and comfortable. On the other hand, when the patient is shocked, algid and hypothermic, warm or hot water can be infused into the stomach by gravity and siphoned off with no disturbance to the patient, who may be entirely

unconscious of the procedure, but who is stimulated and warmed by the heat applied directly to the heart and splanchnic organs in a way that is far more effective than any external application. Of course, this central stimulation by heat in no way conflicts with the artificial warming of the exposed peripheral parts with hot-water bottles, bags, blankets, electric pads, etc., as is usual in reanimating shocked and algid patients.

13. But apart from its many uses as a gastric drain, irrigator and flue (for gases), the Jutte tube, introduced through the nose and allowed to remain permanently in the stomach, is also valuable in other surgical conditions of impoverished nutrition and exhaustion in which the early instillation of nutrient fluids directly into the intestine is indicated. A notable example of such an indication is afforded by advanced cases of pyloric obstruction from benign or malignant stricture, for which a late gastrojejunostomy is performed in conditions of long fasting or marasmus. In such cases it has been our practice, while performing a gastro-enterostomy, to introduce a duodenal tube, previously inserted through the nose, into the jejunum for a distance of 10 to 12 cm. through the newly created stoma, where it is allowed to remain after the gastro-enterostomy has been completed and until the normal gastric functions have been resumed. The tube thus introduced into the jejunum is utilized immediately or shortly after the operation as a transgastric jejunal drip, which supplies a peptonized glucose solution in a far more certain way than when this is administered by the usual rectal drip (proctoclysis).

The manifold uses of the Jutte tube in the surgery of the gastro-intestinal canal are becoming more apparent every day as one of the most precious adjuncts to the post-operative treatment for the especially dangerous class of patients with whom we are now concerned. The growing appreciation of the value of the tube, though referred to in several recently published contributions by gastro-enterologists, is not sufficiently recognized in surgery and deserves a more extended notice.† I have only incidently referred to the uses of the tube in this communication because of its great importance as an auxiliary measure in the very cases in which the intravenous drip is indicated and in which we have found it most frequently applicable.

14. *The Technic of the Intravenous Drip.* As applied in our practice at the Touro Infirmary, the apparatus is of the simplest sort. It is precisely the same as that used for massive intravenous infusion with only a few modifications. (1) A glass graduate container of a capacity of 1 litre or more of solution; (2) a delivery rubber tube which is interrupted by interposing a tapped glass bulb (Murphy "drip bulb") which allows the nurse to observe the rate of flow and count the drops as they are delivered from the receptacle;

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† The value of the duodenal tube in abdominal surgery as a post-operative resource is also emphasized by the following quotation from Bassler (Southern Med. Jour., 1919, xii, 4): "If I leave no message with you, but the use of transduodenal lavage in post-operative ileus, I feel that my paper has not been in vain. Its employment is of distinct advantage and will bring happiness to you."

(3) a thumb-screw clamp which controls the rate of flow; (4) a metallic cannula provided with a beaded or shouldered tip to prevent the canula from slipping out of the vein after it has been tied in place; (5) a Duchesne's electric pad. This is a mechanical device by which intravenous infusion, hypodermoclysis and proctoclysis can be administered at a uniform temperature. The pad with its tail is light, pliable, perfectly safe, easily adjusted and always ready for immediate use, as it can be attached to an electric-light socket. It

FIG. 1.—The Duchesne electric heating pad.

heats quickly, maintains a definite degree of heat as long as desired and the cost is reasonable. " The heating element inside the pad and tail consists of wire interspersed with strands of woven hemp. This wire is of special alloy and threadlike fineness, but is very strong. It is thoroughly insulated with asbestos. A platinum contact thermostat is attached so that a definite degree of heat is controlled automatically at all times when in use. The pad is 9 inches wide by 21 inches long and can be adjusted to various receptacles of various sizes and shapes by tapes attached to either end of the pad. The tail is 54 inches long, 4 inches wide, provided with snaps so arranged as to completely wrap the tubing, and the end at the cannula may be secured to the dressings which hold the arm to an extension splint or board with a safety-pin through the eyelet provided for that purpose. The outer covering of the pad and tail are of waterproof material. The device is so arranged that

the heat produced in the pad will deliver the solution originally heated to 110° F., at a temperature of 100° to 102° F., when it reaches the cannula." We have found this device a most excellent substitute for the old method of keeping the solution in the receptacle and tubing warm by the use of thermos bottles and hot-water bags, which were formerly used at great cost of labor and vigilant attention and yet without obtaining the desired uniform temperature at the cannula. A description of this ingenious and carefully worked-out appliance will be found in the American Journal of Nursing for March, 1923, p. 470, in an illustrated article, by Mary L. Duchesne, R.N.

A number of devices, more or less ingenious, simple or complicated, for the administration of artificial sera and medicated solutions by the drop method, have been utilized for proctoclysis, hypodermoclysis and endophleboclysis (intravenous infusion). Some of these aim solely at accuracy of dose; others at uniform temperature; and nearly all at both desiderata. Among these can be mentioned the apparatus of Holzbach, Friedemann, Ruebsamen and Läwen in Germany; of Thiroloix in France; of Woodyatt, Thalsheimer, Penfield-Teplitzky and Pena in America. With these we have no experience. They are no doubt valuable and meet certain special indications, but for our purpose the simple apparatus above described with the ready and practical warming device of Duchesne, has satisfied all our clinical requirements.‡

15. In connection with the continuous intravenous drip the following points should be remembered: The cannula should have a lateral as well as a terminal opening; it should be made fast to the vein in the usual way by ligating it well over the bulbous tip; the median basilic or other prominent vein is preferred as an ordinary temporary intravenous infusion. A glass-connecting tube should be interposed between the rubber segments of the delivery tube at a distance of 6 inches (15 cms.) from the cannula, so that any backflow of blood or blood-stained solution should advise the operator of an obstruction at the cannula; the cannula should be immobilized and held in place by Z. O. adhesive strips, and, in addition, the terminal end of the delivery tube should

‡ At the time when this paper was read at the meeting of the American Surgical Association in June (1923), the writer had no knowledge of the contribution of Penfield and Teplitzky, on " Prolonged Intravenous Infusion and the Clinical Determination of Venous Pressure," which appeared in the Archives of Surgery for July (vol. vii, p. 1, 1923). The very thoughtful, thorough, scientific way in which these investigators have worked out the problems of the continued administration of intravenous infusions is most creditable and praiseworthy. Apart from the ingenious apparatus devised by these investigators which regulates the rate of flow and the degree of heat of the solution, the manometric indicator of the venous pressure which is attached to the delivery tube, gives the Penfield-Teplitzky apparatus the scientific quality of a physiological laboratory apparatus which is of undoubted value for accurate clinical observation. Great stress, and very properly, is laid by the authors upon the importance of recording the variations in the venous pressure while the infusion is in progress, and the easy reading of the pressure by the manometric indicator provided with the apparatus, constitutes a decided advance in the technic of the method. However, it is evident that in all these years, surgeons everywhere resort and have resorted successfully to intravenous infusions and

be bandaged to the arm to prevent the slipping and traumatizing movements of the cannula, which would provoke the clotting of blood in the vein. For the same reason it is important that the cannula should be kept parallel with the vein and not point into its lumen at an angle. The whole arm, including the hand, should be bandaged firmly to a long, well-padded extension-board splint, and again secured to the bed or to a side table, to prevent motion of the arm in restless patients during the long period of continued instillation. In introducing the cannula the usual care should be observed to see that the solution is actually flowing from the cannula at the moment it is inserted into the vein, to avoid the sudden entrance of air. For the same reason watchful care should be observed to see that the receptacle is kept constantly supplied with the sterilized solution and that the proper drop rate is maintained. The drop count will vary with circumstances; no fixed or rigid rule can be prescribed for any great period of time. The rate of flow must be regulated by the indications furnished by the pulse.

The average rate should be about 40 to 60 drops per minute; slowed to 40, 30 or less, with an improving pulse and a rising blood-pressure. It may be increased temporarily to 150 or to a continuous flow when there is greater need of stimulation, as shown by an empty, small and thready pulse.

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transfusions without the aid of a manometric indicator of the venous pressure. It is precisely because our observations with the long-continued intravenous drip administered by the simple and elementary technic above described, confirm the universal experience and prove that a manometric gauge of the venous blood-pressure is not indispensable or necessary for the safe administration of venous infusions, that our experience is instructive. It is more than probable that if in the beginning of our practice we had been preoccupied with the necessity of an accurate reading of the venous pressure we would have been completely deterred from attempting it. In the same way we have learned by practical experience that the fear of air embolism and thrombosis have been exaggerated; and, later still, we have found that accurate methods of regulating the heat of the infusions are not as essential as we thought them to be. All this does not mean that we should be indifferent to any suggestions, measures or devices that contribute to the accuracy of our procedures or that reinforce our clinical sense by providing visible danger signals or that guard against preventable dangers and complications. Whatever will contribute to the safety of the patient is a welcome addition to our resources, and it is in this sense that the venous pressure gauge of Penfield-Teplitzky is a valuable suggestion in line with scientific progress, which it is hoped will find a more general application in hospital practice. On the other hand, in the surgical emergencies in which intravenous infusion is imperatively called for as a prompt means of relief, the simplest and most quickly improvised apparatus should be utilized. In a general way, the experienced clinician needs no sphygmomanometer or stethoscope to tell him when a patient is in danger from shock and exhaustion, or when the pulse is failing, the heart weakening, the arteries emptying, the veins filling and the capillaries stagnating. But experience is not a measurable quality and the fallacies that underlie individual judgment are so well recognized that the efforts made in every direction to control or supplement the evidence furnished by our unaided senses, by graphic mechanical methods of objective demonstration, constitute one of the most striking advances of modern medicine. Therefore, we must regard as real progress any suggestion or method which, as in this instance, aims at combining with the requirements of practice the precision and automatic registration of varying functional conditions which are the part of laboratory experimentation.

16. *Temperature of the Solution.* In regard to the temperature of the solution this also must vary with conditions. When the temperature of the patient is high the solution should be of an ordinary room temperature and the use of the heating device should be discontinued. When the temperature is falling or hypothermic, as shown by the rectal thermometer, the solution should be warm, at least 100° to 104° F. at the cannula, when in addition to its warming effect, a specially stimulating action upon the myocardium may be expected.

The cause of the frequent occurrence of a reactionary chill and fever, usually while the infusion is in progress, and often within the first hour after the infusion has begun, has been the subject of much discussion. The chill is usually quite pronounced, and is announced with marked shivering and shaking. While the extremities are cold to the touch, the rectal temperature rises rapidly until it reaches 103.5 and 104° F. or more. It attains its maximum height in the first two hours and then gradually defervesces and subsides to normal within the next six or twelve hours. It is more likely to occur when shock is associated with hemorrhage or sepsis. During the chill or cold stage the arterial blood-pressure falls, the pulse becomes rapid and irregular and the signs of venous and capillary stasis are apparent. As the chill passes and the surface temperature rises, the blood-pressure rises, the pulse becomes slower, fuller, rapid, but regular; the lividity and cyanosis disappear, the facies flushes and the extremities warm again. After defervescence the skin becomes drenched by perspiration. This chill and fever which is regarded as a reactionary phenomenon is monoparoxysmal and self-limited. In hemorrhagic patients who have rallied from the effects of the infusion, the defervescence of the fever coincides with the recovery of the patient, *i.e.*, if the source of the hemorrhage has been controlled. As a whole this complication is to be regarded as an epiphenomenon which, while disturbing and tempestuous, is not *per se* of grave prognostic significance. Though I am not able to state the matter statistically, it is my impression that more patients have recovered after it, than those who did not exhibit it. The nature and cause of this reaction is still a matter of conjecture. In our experience it has occurred irrespective of the composition of the solution, whether salt or sugar, alike. It appears to me that it has occurred more often when massive infusions (over 2000 c.c. per hour) were used in the start, rather than when the drop method was resorted to. But as the large majority of our cases were first given massive infusions, we are not able to make an accurate estimate of the relative frequency of the chill and fever after the massive and the drop method. We are quite satisfied that the temperature of the solution is not a cause, neither do we believe that it lies in the presence of foreign material or impurities in the rubber used in the tube, since we have observed the "infusion reaction" has occurred in some patients and not in others, when using the same solution, at the same temperature and with the same apparatus. Variations in the hydrogen ion concentration in the solution used—too acid solutions—have been considered a possible cause of the reaction. While we are not able to express any judgment on the subject, we are inclined to doubt that the cause of this reaction can be explained on this basis. In our experience it may occur after citrated and even whole blood transfusions, as well as after saline and glucose infusion, though it is more frequent after the simple massive infusions of artificial sera. Why a certain number of patients react in this way and others do not, still remains conjectural. Thus far it would seem to be a matter of individual susceptibility; something residing in the patient himself, rather than in the material with which he is infused. But whatever the cause, the occurrence of this reaction does not aggravate the prognosis *per se* and other conditions being equal, it should cause no undue alarm.

17. *Air Embolism and Thrombosis.* Again, in connection with the technic, it is well to state that the two great fears which have stood in the way of the more general application of the intravenous drip—air embolism and thrombosis, with the possibility of a detached clot—have no doubt been very much exaggerated. While it must be admitted that neither of these dangers is negligible and that accidents from these causes may occur, it may be stated, as a matter of fact, that they have never been observed in our experience nor in that of the many observers abroad (especially in Germany) who have recently published their observations. We have previously stated that precautions are taken against air embolism. These consist chiefly in inserting the cannula into the vein while the fluid is flowing from it, then to see that the receptacle containing the solution and the Murphy tap are not allowed to run dry. This is precisely what is done in all cases in which a massive intravenous infusion is given; and, thus far, no accidents have been recorded from this cause in the hundreds and thousands of cases in which the procedure is currently applied in the surgical practice of all hospitals. It is quite well proven by experimentation that it is only the sudden and forceful injection or aspiration of a large quantity of air into a vein that is at all likely to be followed by embolic manifestation.

In regard to thrombosis in the vein, or at least clotting in the cannula, it may be stated that it is not an infrequent occurrence. When this happens the fluid in the cannula ceases to flow automatically and the event is announced quickly by the accumulation of fluid in the counting-drop bulb in the same way that it occurs in proctoclysis. When it is evident that the obstacle is not caused by the mere obturation of the cannula by the venous wall, through displacement or angulation, the cannula should be removed and cleared of clot if this is plugging its lumen. If no clot can be detected in the vein by gently massaging it, the cannula (well oiled) is again reinserted in the same vein. If the wound is not inflamed the procedure can be repeated two or three times with safety. When the wound is inflamed, as shown by a marked areola of redness and œdema of the edges of the incision, as may happen when the drip is prolonged for days, it is best to seek another vein, preferably in the same or in the other arm. It is safer to use the veins of the upper extremity than those of the lower limbs, as the tendency to thrombosis in the legs and thighs is, relatively speaking, greater in the lower than in the upper extremity. The secret in avoiding thrombotic occlusion of the cannula or in the vein lies in the continuance of a steady drip from the cannula; as long as the solution drops at the low rate of 20 to 30 drops per minute there is little likelihood of clot formation, especially when the cannula is kept well fixed and immobilized in the arm. Our experience in this regard tallies exactly with that of Friedmann and others especially experienced in this method. One fact is certain, and that is, that in a very considerable experience in the long-continued intravenous drip (in 2 cases lasting five and six days), we have not had to deplore any accident from a detached embolus.

18. *The Solution.* What solution is to be preferred when an intravenous drip may have to be continued not only for hours but for days? Shall it be plain salt or sugar (glucose) or a complex serum? This question has been made the subject of much discussion ever since Joenischen, of Moscow, first resorted, in 1830, to saline intravenous infusion for the treatment of cholera and other dehydrating diseases. Numerous formulæ of an isotonic or physiological artificial blood serum have been suggested by physiologists and internists long before the intravenous solutions were adopted for surgical conditions. This discussion has practically resolved itself, in modern surgical practice, to the general conclusion that for emergencies and temporary purposes the so-called n o r m a l, decinormal or physiological salt solution (NaCl, 0.7 or 0.9 per cent.) is isotonic and suitable for all practical purposes as a replacing fluid. But for a long-continued instillation, glucose is the best material and should be preferred *a b i n i t i o* w h e n e v e r possible. I arrived at this conclusion more than fifteen years ago following the suggestion of Friedrich, of Marburg, and Lennander, of Upsala, who resorted to glucose solution for hypodermoclysis in septic peritonitis in 1905. When I began the practice of the intravenous drip, in 1911, I first used salt, but soon after substituted a 5 per cent. glucose for the plain
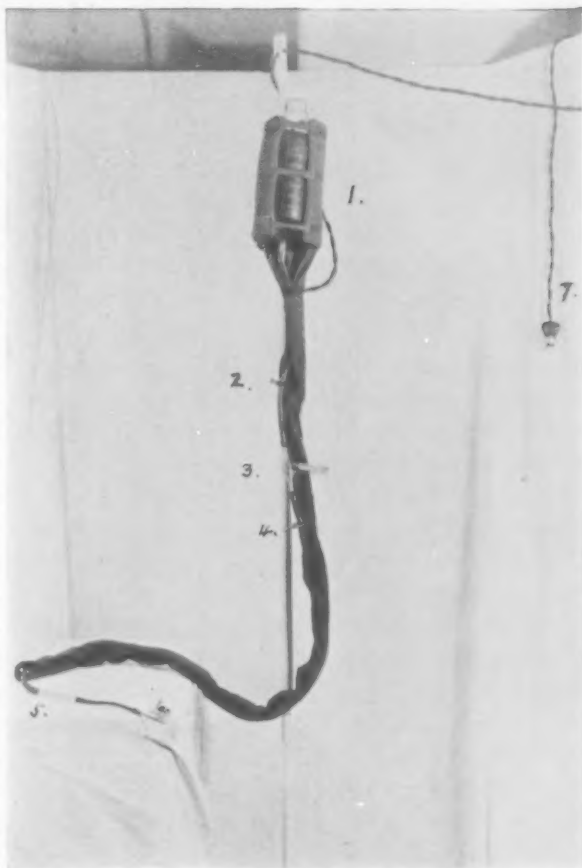
FIG. 2.—The Author's adaptation of an ordinary infusion apparatus for the administration of the "Continued Intravenous Drip." 1. Glass (Kelly) bottle containing glucose or saline solution showing the Duchesne Electric Heating Pad adjusted and folded back, leaving the graduated scale exposed. The tail of the pad is provided with snaps so arranged as to completely wrap the tubing, except for a depth of about 30 cms. from the cannula, which remains uncovered. 2. Screw compressor to regulate the flow of the solution in the tubing leading to the Murphy drip bulb. 3. Murphy drip bulb showing a hypodermic needle inserted in the vent when the solution is to be medicated with stimulating or cardio-tonic drugs (Adrenalin, Pituitrin, Digalen, Strychnine, Caffein, etc.) The bulb is exposed to view so that the drop rate may be always under inspection. 4. Second screw compressor to control the flow in the bulb and maintain a constant visible level of the solution in the bulb, thereby excluding air from the drip. 5. Glass joint connecting the terminal tubing and cannula and exposed to view to detect any reflux of blood from the vein. 6. Cannula, curved and beaded, or shouldered at the tip (to prevent it from slipping when tied to the vein) and provided with a terminal and side opening. 7. Plug and cable attached to the Duchesne pad, ready to connect with an electric light socket.

salt solution. Up to that time (1911) salt solution had been used exclusively in our practice. (See bibliography.)

Saline Solution. While everyone agrees that a normal or decinormal so-called physiological salt solution is isotonic with the blood and is also sufficient, for life-saving purposes in hemorrhage, to replace the lost volume of blood, its continuous intravenous administration is not without serious drawbacks and dangers. As Straub (1920) pointed out the so-called physiological salt solution is not physiological for warm-blooded animals. " He quotes Roessle to show that organic changes occur in the human heart muscle after saline infusions. In some animal experiments, Hoeszli produced tissue lesions in the heart and kidneys of guinea-pigs; lipoid droplets and fat globules appeared in the cells. These degenerative changes can be detected six to seven hours after massive saline infusions. They become most apparent in twenty-four hours and disappear in forty-eight hours. Hoeszli believes that Na-ions play a decided part in the causation of these changes. Thiess pointed out, in 1910, that a healthy man needs 17 gm. of salt per day, but receives 27 gm. when given 3 litres of a 0.9 per cent. salt solution. He maintains that part of the salt is eliminated by the kidneys, but some is retained in the tissues, where it attracts liquids and causes œdema." (Wiedhopf and Hilgenberg, 1923.) This is especially true in patients whose sodium chloride elimination is interfered with in acute toxic or chronic nephritis and in bronchitis or chronic cardiopulmonary diseases in which œdema of the lungs is favored by salt retention. The dangers of salt retention have been too long insisted upon by the French school (Widal and Javal, 1903) and are too well recognized to be insisted upon. The effect of salt retention in disturbing the balance of osmosis and favoring dropsical accumulations are the basis of the now classical saltless diet of Widal, prescribed for the anasarca of nephritis and other dropsical diseases. Consequently, salt infusions, whether by hypodermoclysis, intravenous drip or by any other method of administration are positively contra-indicated in all toxic states in which degenerative changes in the renal epithelium with salt retention occur, and also in all conditions in which pulmonary stasis from an enfeebled cardiovascular circulation predispose to hypostatic œdema of the lungs.

Various formulæ have been recommended as substitutes for plain salt solution. The tendency to return to the older complex formulæ for artificial serum in vogue in the latter part of the last century and even now in physiological laboratories (Hayem, Beaumetz, Jennings, Kronecker, Schmidt, Schwartz, Ringer, Locke, etc.) is shown in the recent recommendation of the normosal of Straub, and still later triple chloride of Thiess (NaCl, KaCl, $CaCl_2$), which he regards as isotonic with blood serum. The quantitative composition of this formula is: NaCl, 0.85 per cent.; KCl, 0.03 per cent.; $CaCl_2$, 0.03 per cent. This solution has been used for years in the clinic of Poppert, of Giessen, and other German clinics with seemingly satisfactory results. (Düttmann.) The objection to all these solutions in their application to the conditions which we are now considering lies in their chloride content

and in their tendency to produce salt retention and its consequent dangers, when continued for a long period of time.

Glucose. These disadvantages and dangers do not apply to glucose. Gaule, a Swiss surgeon, was probably the first, in 1885, to substitute sugar or glucose for salt in hypodermoclysis. Friedrich and Lennander, as previously stated, advocated glucose in 1905—for hypodermoclysis. Glucose was also recommended by Kausch, in 1911, for both intravenous infusions and hypodermoclysis; and by Kuhn, in 1911–1917, as an intraperitoneal infusion and for hypodermoclysic and intravenous use. Through the publications of these surgeons, which showed the superiority of glucose over salt in its nutritive, stimulating, diuretic and antithrombotic properties (Kuhn), I was led to the use of glucose in 5 per cent. solution, which Kausch had recommended as isotonic for hypodermoclysis. Recently, Düttmann, of Poppert's Clinic, Giessen, after a very painstaking comparative study of salt and glucose solutions (he states that a glucose solution, 4.15 per cent., is as isotonic to the tissues and blood as a 0.9 per cent. salt solution), concludes that the prolonged or copious administration of salt is dangerous or, at least, disadvantageous in starving or fasting subjects, not only because it leads to sodium chloride retention in the tissues, thereby favoring œdema, and because of its degenerating effect upon the heart muscle and kidneys, but is also undesirable because it does not relieve the acidosis which is the invariable accompaniment of starvation.

The chief superiority of glucose over salt lies in its high nutritive food value as a foodstuff. If we roughly estimate that a 5 per cent. solution of glucose is equal to 50 gm. of glucose to the litre, then 4 litres, or 4000 c.c. of the solution administered by the intravenous drip in the twenty-four hours, will amount to 200 gm. of glucose (about 7 ounces) in the twenty-four hours. When estimated in calories (1 gm. of glucose = 3.75 calories—Sherman), 1000 c.c. of a 5 per cent. solution of glucose would equal 187.50 calories, and if 4 litres are administered in the twenty-four hours, 750 calories would be consumed per day.

Büdinger's experiments, quoted by Düttmann, have shown that sugar quickly disappears from the blood and causes an appreciable stimulation and increase in metabolic rate, as shown in the great excretion of phosphates and urates in the urine. The body utilizes it without any residue and when introduced in isotonic solution causes no glycosuria. In our experience it is not usual for sugar to appear in the urine of patients to whom we have administered the 5 per cent. solution continuously by drip even for four, five or more days. On the other hand, when denser solutions have been used for diuretic purposes in infusions of from 300 to 500 c.c. of a 30 per cent. concentration (Enriquez's solution), a slight temporary glycosuria has been observed); but solutions of this concentration are very rarely used and only when urinary suppression is threatened, especially since Guiraud's observations § have shown

§ Paris méd., July 25, 1914.

that the infusion of such solutions may be followed by serious metabolic disturbances and toxic symptoms.

Woodyatt and his associates, Sansum and Wilder, in their remarkable experimental studies on the effects of "Prolonged and accurately timed intravenous injections of sugar," in which the questions of the rate of infusion, sugar tolerance and utilization, are especially considered (Jnl. A. M. A., Dec. 11, 1915), determined "that 0.85 gm. of glucose per hour for each kilogram of body weight can be given indefinitely without glucose appearing in the urine." Among other deductions they conclude that "a man weighing 70 kg. when resting quietly may receive and utilize 63 gm. of glucose by vein per hour without glycosuria. He then receives 252 calories per hour, a rate corresponding to 6048 calories per day. If his resting requirements were 3000 calories per day he would thus receive double what he needed or enough to cover the caloric expenditure of the same man during heavy physical exertion. Intravenous nutrition with glucose is thus proved to be a feasible clinical proposition and the way is open for experiments with amino acids, polypeptids, etc."

Since in our practice with the continued drip we have utilized only a 5 per cent. glucose solution and have rarely exceeded 5000 c.c. of the solution in the twenty-four hours, it follows that the maximum dosage of glucose obtained in the twenty-four hours would only exceed a fraction over 10 gms. per hour, which is less than one-sixth the quantity that Woodyatt estimates can be utilized by the organism in normal individuals, without glycosuria. This accounts for the rarity of glycosuria in our patients though the conditions under which the drip was administered are very different and less favorable for sugar utilization than in normal individuals. The field is open therefore for clinical observation, especially now that insulin is available to utilize any excess of sugar that may be indicated in the urinary overflow, for its food value.

My experience, as a whole, leads me to agree thoroughly with Düttmann's conclusions that an isotonic glucose solution should be preferred to saline solutions in all cases in which a parenteral supply of fluid and food is needed by fasting, shocked and exhausted subjects. Furthermore, I would add that a 5 per cent. glucose solution is isotonic and is especially indicated when an artificial serum for blood replacement is to be administered for long periods of time, as by our continuous intravenous drip method. And, again, glucose is especially indicated in patients suffering from renal or cardiopulmonary lesions in whom salt retention is most dangerous.

19. *Adrenalin.* As an efficient adjunct to glucose solution in stimulating the myocardium and in raising the blood-pressure we depend upon adrenalin, 1 to 1000 solution. It rightfully claims the first place in artificial stimulation by the intravenous route when injected cautiously as needed, in accordance with the indications furnished by the pulse and blood-pressure. The adrenalin solution is injected, drop by drop, with a hypodermic syringe, the needle being inserted into the vent of the Murphy tap, or by the Crile method, directly into the delivery tube near the cannula. One drop is injected at a time and the effect carefully noted. If the usual marked effect in improving the pulse is observed, the adrenalin is discontinued. As a rule, not more than 5 to 10 drops are injected at a time in sequence. The adrenalin is repeated only according to indications furnished by the pulse and blood-pressure. Usually after a decided effect is obtained by the adrenalin the continued glucose drip suffices to maintain the improved quality of the pulse.

We have seen no advantage in the continued administration of the adrenalin as a permanent infusion mixed with the glucose solution. In Germany, a great deal of stress is laid upon the continuous administration of the adrenalin, and it is given mixed with the salt solution (which is still used in most clinics) in the proportion of 1 c.c. of the 1 to 1000 adrenalin to the litre of the normo-sal solution. (Wiedhopf and Hilgenberg.) In our practice the interne or nurse is instructed to administer the adrenalin only when the pulse is growing more rapid and shallow. The main reliance is placed upon the stimulating and blood-replacing effect of the glucose solution alone when it is continuously applied by the drop method. Other drugs, such as pituitrin, morphine, the soluble digitalis preparations, strychnine and caffeine are administered by injecting them directly into the Murphy tap or into the rubber tube which delivers the glucose solution into the circulation. Camphor oil we use frequently, but only subcutaneously.

Oxygen. We have had no experience with Küttner's suggestion that the solution used for an infusion can be improved by oxygenating it. On the basis of his experiments, 1 litre of normal saline solution can take up and hold 20 c.c. of O_2. This suggestion strikes me as rational and well worthy of consideration, but in the conditions in which we have resorted to the continued intravenous drip we have not found it practical to extemporize the oxygenated solution, though it would appear quite feasible to prepare it in prolonged cases. Presumably glucose solution could be saturated with oxygen as well as salt solutions, but it will require further experimentation and clinical experience to determine its practical advantage.¶

Results. Wiedhopf and Hilgenberg, operating for septic peritonitis from various causes in Läwen's Clinic (Marburg), applied the intravenous drip in 52 cases which had been recorded in that clinic during the last two years (up to the date of their publication, in 1923). They used saline solution (Straub's formula) in combination with adrenalin in the proportion previously stated. Ten of these patients died within the first twenty-four hours. These patients were regarded as inoperable, practically moribund, but the operation was risked in spite of the bad prognosis; presumably the improved circulation obtained by the drip justifying the intervention. In 25 cases the collapse was caused by peritonitis. The majority of the cases were infused ("dripped") after operations for peritonitis caused by appendicitis; a few were perforating gastric ulcers or ruptured gall-bladders. Post-operative failure of the circulation was the chief indication for the intravenous drip in 19 cases. The total mortality and causes of death are not stated.

My personal experience with the intravenous drip, though it goes back to 1911, does not exceed 26 cases. We began, as previously stated, with

¶ Friedemann (Zentralbl. f. Chir., 1921, No. 4, p. 114) has put in practice Küttner's suggestion and described an ingenious electric-heating apparatus to which is attached an oxygen cylinder. A stream of the gas is run through a normal saline solution in the warmed receptacle. He has applied this successfully in one case of ruptured tubal pregnancy, the solution being infused for nine hours by the intravenous drip method.

saline solution, 0.7 per cent., but after the first few cases we substituted glucose, 5 per cent., and have continued this solution to the present time. In the beginning and up to the last few years we resorted to the intravenous drip only in very exceptional, unusual and desperate cases. More recently, as our experience has increased and we have gained more confidence in its safety, we have enlarged its field of application and applied it with greater frequency. Owing to this exceptional and restricted use to the gravest cases, the total mortality has not been less than 60 per cent. The comparatively small number of cases in which the method has been applied in our clinic is accounted for by the fact that the majority of our cases have been treated for conditions for which the usual methods of proctoclysis, hypodermoclysis or a single intravenous infusion or blood transfusion have sufficed to meet the immediate indications. In a large emergency hospital or ambulance service the indications for intravenous drip would be, I am sure, enormously increased, to the great advantage of the patients.

I regret that I have not been able to tabulate the number of cases treated in my service with all the details necessary for an accurate report, but I am gathering all the available records of patients operated by myself and other colleagues who have adopted the method, with the expectation of the early publication of a detailed report. Suffice it to say that in the extremely grave and complicated (and too often hopeless) cases in which I have resorted to the drip in the past the mortality rate is necessarily very high and that the failure of the drip to save life is no criterion of its efficiency or inefficiency except for the particular purpose for which it is applied. In addition, the proper and safe application of the intravenous drip for protracted periods of time demands the constant and vigilant attention of thoroughly intelligent and competent attendants who are not always available. A few examples would suffice to show that in spite of a revived circulation, well sustained by the intravenous drip, death will inevitably occur when irreparable damage has been inflicted upon the organism in any of its vital parts. For instance:

A man, aged fifty-one years, was admitted to my service at the Touro Infirmary in April, 1913, suffering with a strangulated inguinal hernia. I had to resect two feet of gangrenous gut. The continuity of the resected bowel was restored by a circular enteror-rhaphy. The patient recovered from the operation and was improving, when he developed an acute gangrenous cholecystitis which had been latent for years. The gall-bladder was promptly drained and two calculi removed. The gall-bladder had perforated and a quantity of pus and bile had escaped into the peritoneum. An intravenous drip was instituted and the patient rallied and was seemingly recovering after consuming more than 8000 c.c. of glucose solution. On the fifth day, however, he suddenly developed cerebral symptoms and died in profound coma. The post-mortem revealed a large cerebral abscess which had ruptured into the lateral ventricles, flooding them completely with foul, colonic pus. Here the circulation was well maintained up to the last few hours before death.

In another instance, a woman, aged thirty-two years, suffering from an obstructing rectal carcinoma, was operated on June 10, 1922. An artificial sigmoid anus was created as a preliminary to a radical amputation of the rectum. The operation presented no unusual features and the post-operative sequelæ were uneventful until the fourth day,

when she suddenly collapsed, with excruciating pains in the abdomen and signs of acute intestinal obstruction. The circulatory collapse in this case was profound and death seemed imminent. A glucose intravenous drip was started at once and the patient warmed up and rallied promptly. The abdomen was then opened and a coil of gut, representing the greater part of the jejunum, was found strangulated in the left para-duodenal fossa of Treitz. The gut was extracted with great difficulty from this pouch, and when exteriorized was found to be cyanotic, purple and with a number of suspicious spots suggesting the beginning of necrosis. By pouring pitchers of hot salt water over the gut the color and motility improved sufficiently to justify us in replacing it in the cavity. The artificial anus at the sigmoid, made five days previously, was now function-ing actively and discharging quantities of gas and fluid fæces. Through this ordeal the pulse was remarkably well sustained and gave us no anxiety, the intravenous drip continuing uninterruptedly all the time. Nonetheless, and in spite of the remarkably good pulse, the patient died on the fifth day. The necropsy showed that death had been caused by mesenteric thrombosis and consequent gangrene of the gut in patches.

In this case the patient consumed in six days, beginning with the collapse, 14,800 c.c. of a 5 per cent. glucose solution, or nearly 15 quarts, of which 2000 c.c. were of 0.7 per cent. saline, all administered by the intravenous drip with the intermittent addition of adrenalin drops, as these were specially indicated. In this case the drip more than filled our expectations in holding up the circulation to a remarkable degree. Toward the end, while the pulse held well, the respiration became shallow, intermittent and failed before the pulse gave way. No wonder that under such overwhelming sepsis the most effective support to the circulation was of no avail. In this case the Jutte tube in the stomach was of immense service in preventing vomiting and keeping the patient comfortable by constant gastric lavage and drainage.

On the other hand, the value of the intravenous drip as a life-saving measure is shown in a more favorable light in the following case:

A farmer, aged forty-eight years, tall, profoundly anæmic, almost marasmic from long fasting and intestinal hemorrhage, was referred to me in April, 1918, with a diag-nosis of duodenal or gastric ulcer. He had been in the infirmary scarcely two days while undergoing preparation for operation, when he developed all the signs of an acute peritoneal collapse. The abdomen was promptly opened and a perforating ulcer of the first portion of the duodenum was recognized. The extravasated duodenal contents were carefully wiped out and the perforation closed by suture of the partially excised and inverted edges. A single massive intravenous glucose infusion rallied the patient and he seemed to be recovering, but on the fifth day signs of suppuration in the right hypo-chondrium with diaphragmatic pleurisy appeared. The patient, who had been dieting for many months before the operation, was exhausted and extremely emaciated. At this juncture his pulse began to show signs of a progressive and alarming weakness. A continuous intravenous drip was now instituted, and following its good effect a large collection of pus was drained from the subphrenic space by a transpleural thoracotomy; to do this effectively the ninth and tenth ribs had to be resected. The patient could now scarcely nourish on account of the constant regurgitation of the gastric contents. His anal sphincter was too weak to retain the rectal drips and systematic hypodermoclysis failed to improve his circulation. The continued intravenous drip gave us the only hope to supply him with fluids and food, and after this had been instituted it was allowed to continue unremittingly for five days, when he began to retain water and nutritive fluids by mouth. The pulse, which had been reduced from 140 to 150 to 110 by the drip, then continued to retain its good quality after the drip had been temporarily interrupted

to test the improved stability of the pulse. In view of the continued improvement of the pulse the cannula was removed from the vein and the drip permanently discontinued. During the five days that the drip had been in operation the patient had consumed 22,000 c.c. of glucose solution. The patient finally recovered after a long convalescence. He returned on June 22, 1920, with a cicatricial stricture of the duodenum, which was completely relieved by a posterior gastro-enterostomy. He has since been heard from, expressing himself as perfectly well and attending to his usual occupations. In this case blood transfusion was indicated even before the perforation of the duodenal ulcer had occurred, but it is doubtful that it would have had the permanent stimulating and nutritive effect that the continued glucose drip exercised during the prolonged period of exhaustion and gastric intolerance for food and drink that this patient displayed after the operation.

In another and more recent case the intravenous drip carried the patient through a critical period of collapse from hemorrhage and permitted a Cæsarean section to be done, with recovery without recourse to blood transfusion:

Mrs. F., primipara, aged twenty-five years, was admitted to the Touro Infirmary on July 15, 1923. She had arrived nearly at term, but was suffering from frequent and copious hemorrhages caused by placenta previa. Efforts to dilate and deliver by podalic version had been made by her attending physician, Dr. F. Larue, but the deluge of blood that followed compelled a hasty tamponade, which had to be renewed on account of the constantly recurring hemorrhage. It was decided that a Cæsarean section was necessary, but the patient was so bleached and collapsed from hemorrhage and exhaustion that we proceeded with an intravenous glucose drip, pending the typing of the husband's blood preliminary to transfusion. The transfusion, however, was postponed and not carried into effect, as it was not found necessary. The pulse was steadily growing weaker and the hæmoglobin had fallen to 60 to 50 per cent. Under the influence of the continuous intravenous drip the pulse improved and we were able to deliver a dead fœtus without great difficulty. The cannula was allowed to remain in the vein and the drip was continued all that day, when the pulse and general condition had improved so much that the drip was discontinued. In the course of twelve hours the patient had received 3800 c.c. of 5 per cent. glucose with several intermittent additions of pituitrin and adrenalin. She was fortunately able to nourish and drink by mouth, and in this way made an excellent recovery and was discharged well, though still slightly anæmic, twenty-one days after her delivery.

In this case the glucose drip allowed us to dispense with what seemed at first to be a necessary blood transfusion.

The preceding cases, which have been merely sketched in outline are quoted to illustrate the class of patients in whom we have resorted to the intravenous drip, but they could be multiplied many times over if space would permit a detailed account of the 26 patients in whom we have found this measure specially indicated. In view of the desperate character of all of them, it is not surprising that fully 60 per cent. succumbed to the primary or secondary causes that brought the patients to the operating table. If the continued intravenous drip had been used as a routine method in the class of patients in whom we still use proctoclysis, hypodermoclysis or massive infusion or transfusion the intravenous drip would indeed make a most brilliant showing. Thus far we have limited the application of this method to the cases in which other procedures requiring less vigilance, prolonged attention and intelligent discretion on the part of the attendants suffice, ordinarily, to meet the indi-

cations. There is no reason why the intravenous drip should not be extended with advantage to a far greater number of indications provided competent assistance is available.

In conclusion, allow me to repeat that for certainty of dosage, promptness and duration of effect in sustaining a weak or failing circulation none of the methods of cardiovascular stimulation at present in vogue can compare with the continuous intravenous drip. When glucose is made the basis of the infused fluid, the continued intravenous drip is incomparably superior to all the other methods of parenteral nutrition and medication, as it supplies continuously an easily assimilated foodstuff in isotonic solution for an indefinite time. In this way, it serves the purpose of a blood-replacing and nutrient fluid, constantly supplied; in addition it is a cardiovascular stimulant, a diluent (of toxins and catabolic products), an eliminant (especially by the renal route) and a neutralizer of the acidosis which is present and so often adds to the dangers which beset the precarious existence of the patients now under consideration.

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SOME PROBLEMS OF JAUNDICE AND THEIR SIGNIFICANCE IN SURGERY

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THE diseases of the liver and in connection with them the problem of jaundice have recently aroused greater attention. New investigations deepened our knowledge of jaundice and made it possible to distinguish different groups. It is my aim to show in this paper, how we can use these new methods in surgical diagnosis and in our operative indications.

What is jaundice? It is the partial or complete retention of bile constituents in the organism. This definition involves two facts: that yellow skin or sclera caused by other than bile-pigment must be excluded from the conception of icterus—as for instance, the yellow color of diabetic and arteriosclerotic patients caused by increased lutein-index of the blood and tissues, or the yellow color of patients after intravenous injections of trypaflavin, all conditions that might be the cause of error, when preliminaries are unknown. The second conclusion we are able to draw from the above definition is a distinction between two kinds of icterus. The one—*complete icterus*—is present, when all bile-constituents are circulating in the blood; also not only bile pigment, but bile-acids, cholesterine and besides other products of decomposition, that usually leave the organism with the bile. This complete icterus can be called *cholæmia* in the sense that all constituents of the bile are circulating in the blood. In contrast with this kind of jaundice we can discern a partial retention, or as the French school calls it, dissociated icterus, when only the bilirubin circulates in the blood and all other constituents are missing. Cases are described, when only the excretion of bile acids is disturbed. In my personal opinion this bile-acid icterus is only apparent and is the consequence of the different elimination index of bilirubin and bile-acids. To explain this statement in other words, while the bilirubin must attain the concentration of 1.5–2 mgr. per cent. in the blood to be able to pass through the kidneys and color the tissues, the biliary acids immediately pass the kidney as soon as they appear in the blood. This explains why generally no visible jaundice develops after a biliary colic, but bradycardia, skin itching, diminished surface tension of the urine can be observed, all signs, that the excretion of biliary acids is disturbed. And still we cannot regard this as a case of dissociated icterus, because biliary pigment is retained too, although in a concentration not high enough to appear in the tissues. I have to state that this principle difference between the elimination of biliary pigments and acids has not been noted and valued in literature.

Now in contrast to *cholæmia,* we can call the dissociated icterus a *bilirubinæmia,* the pigment retention alone being possible: the isolated retention of cholic acids is not sufficiently proved.

Hymans van der Bergh and after him Lepehne succeeded in distinguishing clearly two kinds of jaundice by the help of a simple chemical reaction. In every case, where jaundice had a mechanic cause, this reaction took place immediately, without the addition of alcohol, while in cases where no impediment in the bile flow could be found (no obturation, obstruction or compression of the bile passage) the chemical reaction could only be obtained immediately in the presence of alcohol; on this basis they distinguished a mechanical and a functional bilirubin in the blood, the latter being the result of functional incompetency of the liver cells to excrete the normal amount of bilirubin, or, on the other hand, an increased pigment production in the reticulo-endothelial system. Lepehne showed that both groups can appear at the same time, when both factors, mechanical and functional are present.

It is easy to see that complete and partial icterus or cholæmia and bili-rubinæmia correspond exactly to mechanic respectively functional icterus. In other words, that the different chemical behavior of bilirubin, explained by Hymans van der Bergh as a different chemical activity of the same pigment, ought to be explained by the presence of the other bile constituents, cholic acids and cholesterine. Yet experiments *in vitro* had negative results. The difference between mechanic and functional bilirubin turned out to be the question of whether the pigment has passed the liver or not, whether it is freed from its albumen by the liver or not. It was possible to turn functional bilirubin into a mechanical one, by digesting the albumen in a thermostat with pepsin, which experiment is of great theoretical importance.

After this short resumé let us proceed to see the practical use of the above considerations. What is jaundice clinically? It is a symptom, not a disease; it can be caused by any disturbance in the bile passage, by the insufficiency of liver cells and by the hyperfunction of the reticulo-endothelial system. It is of greatest practical importance to be able to distinguish the different sorts of jaundice before an operation. It cannot happen then, that a case of hæmo-lytic jaundice—a disease accompanied by jaundice and colic—should be taken for gall-stones. Until now the diagnosis of jaundice was simply based on the yellow color of skin and scleræ, the contents of urine in cholic acids and pigments. The analysis of blood concerning bilirubin is a simple test, that helps to detect icterus in cases, when the bilirubin is neither visible in the tissues, nor has appeared in the urine, because it has not attained the concentration of 2 mgr. per cent. in the blood. Examining blood in cases one or two days after the biliary colic, I succeeded each time in demonstrating increased bilirubin index in the serum, although neither scleral icterus nor any pathological contents of the urine could be found; one can also find more cholesterine in the blood after every biliary colic. This latent icterus can be of great diagnostic help in cases of colics with unknown origin. Further, the importance of minimal degrees of hæmolysis, also to be detected by slightly increased bilirubin index can be of high importance for indication to splenec-tomy. In cases of visible let us say *manifest icterus;* it is the quality of

icterus that will interest us. Is it a cholæmia or is it a bilirubinæmia? This will decide the quality of the operation and will guide our pre-operative preventive measures. The liver, heart and kidneys of icteric patients must be carefully examined. We know, too, that even purely mechanic jaundice leads sooner or later in consequence of the increased bile tension to functional disturbances of the liver, anatomically to biliary cirrhosis. On the other hand, functional icterus, bringing constantly more pigment to the liver, than it is able to work off, cannot be harmless to liver cells.

Now besides these secondary liver alterations, the knowledge of primary liver diseases is extremely important for the surgeon, partly because they might be the cause of diagnostic failures (lues hepatis, subacute liver atrophy taken for gall-stones) and partly on account of the narcosis. Chloroform is a well-known liver poison, that can produce in people with seemingly intact liver, acute yellow liver atrophy. On the fourth to sixth day after the operation the patient gets icteric; symptoms of vomiting, colic, delirium appear, and lead to death. The post-mortem shows a severe fatty degeneration of the liver. If death takes place a little later, centroacinous necrosis is the most evident symptom. Icteric patients should never get a drop of chloroform; even ether is to be avoided if possible. By a local anæsthesia of the abdominal wall with intercostal injections on the right side and eventually splanchnic blockade combined with a short ether, or etherchlorid—Rausch— any operation on the biliary or splenic system can be performed. Even so, as my statistics will show, the degenerated liver, heart and kidney, prove to be insufficient in an astonishing percentage of cases. The heart is attacked by the cholic acids. These poisons are very closely related to digitalis and lead to myodegeneration; the epithelium of the tubuli contorti in the kidney degenerates and proves insufficient at the slightest stress. Here is the essential difference between cholæmia and the bilirubinæmia. While the bilirubin is only a harmless pigment, the cholic acids are poisonous for heart and nervous system and play an important part in the digestion of fat. Brulé's cholic acid test is based on this latter fact.

A most important question is the relation of the jaundice to hemorrhage. The hæmostasis in wounds depends less on coagulation than in first line on the agglutination of blood discs; this can be controlled by Duke's test. Duke's bleeding time, normally two to two and one-half minutes, can be easily determined anywhere without special technical arrangements. The prolongation of bleeding time by normal coagulation is a symptom of thrombopenia. That is why patients suffering from pernicious anæmia bleed so profusely. One finds on the contrary, in spite of a normal number of thrombocytes, long coagulation and long bleeding time in cases of hæmophilia, cholæmia, hirudin and phosphor-intoxication; in these cases the fibrin-production of the liver seems to be disturbed. Finally we can examine the condition of the blood-vessels, as regards their endothelium, by tying the arm up tightly for ten minutes and looking for tiny subcutaneous hemorrhages (endothel symptom). The practical conclusion for surgeons is that if Duke's test (bleeding time)

is normal, we need not care for the coagulation time or for the endothel symptom, because every toxic agent that prolongs coagulation time acts upon bleeding time, too. The contrary, long bleeding time with normal coagulation, exists, and is characteristic for thrombopenia. We present on Table I the hemorrhagic conditions of 17 icteric patients. (Table I.)

The long bleeding time in cases of cholelithiasis with jaundice always means disturbed liver function and goes together with Widal's " *crise hæmo-clasique.*" We give in every case of jaundice, where bleeding time is longer

TABLE I

	Diagnosis	Number of cases	Bleeding time	Coagulation time	Endothel symptom	Widal's crise hæmo-clasique
Cholæmia	Cholelithiasis	6	normal	normal	—	—
	Cholelithiasis	4	long	long	—	+
	Cirrhosis Hanot	1	long	long	—	+
Bilirubinæmia + thrombopenia	Ict. hæmolyt	3	long	normal	—	—
	An. perniciosa	3	long	normal	+	—

than two and one-half minutes, 1 gramme of calcium bromid *intra venam,* three days long. Serum and gelatine can be given, too, but personally I would prefer calcium. X-raying spleen and liver for hæmostasis could be tried. We have no personal experience of this method. Opinions seem to be divergent concerning its efficacy. Since we have been preparing patients during three days with calcium, we have lost no patient by post-operative hemorrhage, at all events, the shortening of the bleeding time shows best the value of these injections.

As to the surgical treatment of the different kinds of jaundice: In cases, where there is obstruction in the bile passage, we try to remove the obstacle, the cause of occlusion, obturation, constriction or compression. If this proves to be impossible, we try to connect the biliary system above the obstacle with the gastro-intestinal tract; if this also is not possible, we will make an external biliary fistula and give bile extracts internally.

It would transgress the extent of this paper to discuss the results of our gall-stone operations. I will only give the numbers as far as they are connected with jaundice. In Table II, I divide all cases of gall-stones into three groups. (Table II.)

I. *Simple cases,* where the process has not transgressed the gall-bladder,

also *hydrops* or even *empyema vesicæ felleæ,* without notable adhesions in the surrounding parts.

II. *Complicated cases.* I understand serious adhesions, exuberations, fistulas, and conditions that make an intervention of the deeper biliary passages necessary, but no apparent jaundice exists. Stones in the choledochus, moving freely, and not definitely hindering the bile flow, belong to this group.

III. In this group I place all jaundiced gall-stone cases. The mortality of this group is 36 per cent. But if we select the cases where jaundice lasted

TABLE II

Gall Stone Cases from 1914–June 1922 (I. Surgical Clinic, Budapest).

Cases	Number of cases	Mortality	%
I. Simple cases......................	129	2	1.5
II. Complicated cases no icterus.......	139	7	4
III. Icterus..........................	63	23	36
Icterus not lasting a month...........	36	9	25
Icterus over a month.................	27	14	55
Total................	331	32	9

Tumors (malignant) of biliary tract.

Cases	Number of cases	Mortality	%
I. No icterus.........................	6	1	17
II. Icterus...........................	9	4	45
Total................	15	5	33

less than a month in contrast to cases lasting over a month, we find the astonishing numbers of 25 per cent. and 55 per cent. This latter percentage explains the endeavor of surgery to treat jaundiced patients, if short internal treatment has proved to be useless, surgically as soon as possible. Of course one will willingly wait after a biliary colic that appears with jaundice for some time, as 30 per cent. of all patients suffering from cholelithiasis have jaundice in their history, and it is better to wait for an interval before operation, as the mortality of the operations during the attack is just double—but it is the greatest possible mistake to wait longer than four weeks, as our numbers prove.

The so-called prophylactic operations, proposed lately by several authors in analogy to appendicitis, are superfluous in my opinion, because the gangrene, the perforation of the gall-bladder, occurs in a very low percentage of cases, and always has its alarming symptoms. We operate on gall-stones—

not speaking now of acute inflammatory and obstructive cases—when a rational medical treatment does not bring the process to a latent state; in other words, if the treatment does not succeed in curing the inflammation. This should be the territory of internal treatment; the mechanic factor cannot be influenced till now medically.

The treatment of liver diseases accompanied by jaundice is not in the surgeon's line; but of course all secondary liver-cell disturbances, that arise through congestion of bile or increased pigment production, can be improved or quite cured by removing the original cause. It has been further proved that the increase of liver diseases in defeated countries is caused by the diminished glycogen—contents of the liver. Roger recommends a copious supply of carbohydrates for patients suffering from insufficiency of the liver. I have personally tried to overcome the liver incompetency on our last five cholæmic patients by giving intravenous and rectal infusions of glycose; the results are very promising. The sugar has a favorable effect in every respect. It is the best nutrition for the heart, it supplies the liver with glycogen, it works against post-operative acidosis that is especially excessive in cases of jaundice and is still increased by calcium given as a hæmostatic.

The knowledge of functional disturbances of the liver is eminently important for the surgeon. Unfortunately, the functional tests known till now, are neither simple nor quite reliable, besides, considering the manifold functions of the liver, one test can never be sufficient. In regard to the chologen functions of the liver, I found the ratio of the serum and bile concentration of bilirubin, a very fine indicator of hepatic function (Hetenyi's test). The test is especially useful in cases of functional jaundice and of course quite useless in absolute obstruction, where no bile can be obtained with the duodenal tube. I would like to insist upon the fact that as the mortality of operations on the urinary tract sank after the systematic employment of tests for kidney function, so could we reduce the enormous mortality of obstructive, although not malignant, jaundice, if we were aware of the condition of the liver. In the presence of high degrees of hepatic insufficiency one could previously make a biliary fistula, and freeing the liver cells from the great bile tension, give them the possibility to resume their function; every surgeon has seen cases of obstructive jaundice with seriously afflicted, cirrhotic livers, heal with absolute restitution after the removal of the mechanic obstacle.

Lately an effort has been made to cure hypertrophic and atrophic cirrhosis of the liver, especially cases with enlargement of the spleen with splenectomy. On the other hand, one tried to discharge the afflicted liver in cases of acute and subacute yellow liver atrophy with choledochotomy. Our own experience is much too small to enable us to form a definite opinion concerning these operations.

Syphilis of the liver sometimes makes diagnostic difficulties and it must not be forgotten that every icteric blood serum can give a positive Wassermann test without any luetic infection.

The third group of jaundice, that of hæmolytic origin, has lately given the greatest surgical results. Every hæmolytic icterus should be operated on as soon as possible, pernicious anæmia only if hæmolysis can be shown (increased bilirubinæmia). In diseases belonging to this group jaundice disappears in a short time after splenectomy. I tried to show above that the bleeding of such patients is of quite another origin than those attained by cholæmia. The latter is the result of disturbed liver function, while the former is caused by a reduction or absence of blood plates (thrombocytopenia). Splenectomy has here a marvellous effect; the number of thrombocytes can increase from 30,000 to 300,000. Clinically the diagnosis is made by following observations: long bleeding time, positive endothel symptom, normal coagulation.

The following Table III shows our surgical results concerning functional icterus. In operating for pernicious anæmia we must be careful to exclude all cases of aplastic anæmia (functional test for bone-marrow, Takats), second-

TABLE III

Cases of Functional Icterus 1914–1922 (I. Surgical Clinic, Budapest).

Diagnosis	Number of cases	Mortality	%
Icterus hæmolyticus..................	8	0	0
Anæmia perniciosa..................	51	20	40

The mortality of the last 20 cases: 12 per cent.

ary anæmia, all cases with absolute liver incompetency and all patients under 20 per cent. hæmoglobin and 1,000,000 red corpuscles. With such precautions temporary results will increase.

I must mention too that several cases of hepatic and hæmolytic jaundice had gall-stones. A reason more to operate on these cases as soon as the diagnosis is made.

CONCLUSIONS

The following conclusions can be drawn from the facts above:

1. With a simple chemical reaction we can easily distinguish two groups of jaundice, that are best called: cholæmia and bilirubinæmia. The first is caused by any disturbance in the bile flow or by the incompetency of the hepatic cell, the latter is an overproduction of bilirubin, in consequence of an increased degree of hæmolysis.

2. The intact liver function is of high importance for the surgeon. Its disturbance will produce a longer bleeding and coagulation time, a great susceptibility for narcotics and a marked acidosis after the operation. Therefore an exact examination of the liver function is of high importance.

3. In consideration of the eminent dangers of cholæmia, these patients should be submitted to operation as soon as possible. There is vital indication after four weeks.

4. Jaundice of hæmolytic origin can be cured by splenectomy, although one might not always succeed in healing the actual disease. In cases of thrombopenia the hemorrhage ceases after splenectomy, although the increase of blood plates is only temporary.

An attempt has been made in this paper to discuss some of the questions of jaundice, that have special interest for surgery. In the present state of surgical technic, the evolution of surgical treatment should not consist of inventing new operations, but rather in possession of exact diagnostic measures: to avoid the dangers of narcosis and post-operative bleeding, hand in hand with subtle control of liver function. Only so can a further improvement in our results be hoped.

INTRATHORACIC TUMORS *

EXPERIENCES WITH EIGHT CASES OF TUMOR OF THE THORACIC WALL PLEURA AND MEDIASTINUM

By George J. Heuer, M.D.

of Cincinnati, Ohio

AMONG a goodly number of patients with thoracic conditions which we have seen in the past few years have been eight who presented tumors of the thoracic wall, pleura or mediastinum which seemed to be operable. They were therefore subjected to operation and an attempt made—although not always successful—to remove the new growths. They form, especially from the viewpoint of the nature of the tumors, an interesting small group.

CASE I.—The first case is one of intrathoracic *calcified cyst* arising from the anterior mediastinum and projecting into the right thoracic cavity. The case was reported in the *Review of Tuberculosis*, May, 1917, No. 3, vol. i, and I refer to it again in order to report upon the end-result.

The patient was a colored man, aged fifty-three years, who entered the Johns Hopkins Hospital, October 31, 1916, complaining of pain in his right chest. The onset of his illness was stated to have occurred three weeks before, when, after lifting a heavy bag of cement, he had a sharp pain in his right side accompanied by coughing. He left his work and on the advice of his physician went to bed and remained there until his admission. Pain and paroxysms of coughing with abundant yellowish sputum were frequent. There was no hæmoptysis.

On physical examination the right chest was flattened and there was limitation of respiratory movements. There was dulness below the third rib in front and flatness below the sixth rib. Over the back there was flatness below the sixth thoracic spine. A provisional diagnosis of pleurisy with effusion over the right base was made. An attempt at aspiration, however, was unsuccessful, the exploring needle meeting an unyielding resistance. X-ray plates (Figs. 1 and 2) showed a well-defined shadow within the thorax suggesting a calcified cyst. A positive diagnosis was not made. Sputum examinations repeatedly made gave no information of value. Dermoid cyst, echinococcus cyst, encapsulated empyema and neoplasm were the possibilities suggested.

Operation was performed November 8, 1916. A long incision, encircling the right half of the thorax, was made and practically the entire ninth rib removed. The parietal pleura was stripped from the thoracic wall over a wide area to give us a better opportunity for exploration. Directly under the mobilized pleura was felt a very hard mass of large size. An incision was made through the pleura and the freeing of what was evidently a calcified mass begun. It was a slow, difficult procedure, due to the adhesions between the mass and the pleura, lung, diaphragm and mediastinum. Eventually, however, it was freed down to an area about 6 x 4 cm. in diameter, where the mass was densely adherent to the pericardium and great vessels. Here the calcified shell was replaced by fibrous tissue, and it was during the separation of this portion of the mass that some of its contents—a thin, yellowish, purulent material—escaped. It was thought advisable, therefore, after removal of the mass, to drain the thoracic cavity.

Post-operative convalescence was uneventful. The wound healed nicely. The lung promptly expanded to fill the large cavity left after the removal of the mass. The patient was discharged with his wound healed.

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* Read before the American Surgical Association, June, 1923.

Comments.—From an operative standpoint there was nothing difficult about this case, although the enucleation of the mass, and especially its separation from the pericardium and great vessels, was tedious. Simple ether anæsthesia without any pressure apparatus was used, and throughout there were no respiratory difficulties. The exposure through a simple long incision was adequate even for the removal of so large a mass. The diagnosis remains in doubt. The specimen consists of a calcified shell as large as an infant's head without a lining membrane (Fig. 3). The most careful examination
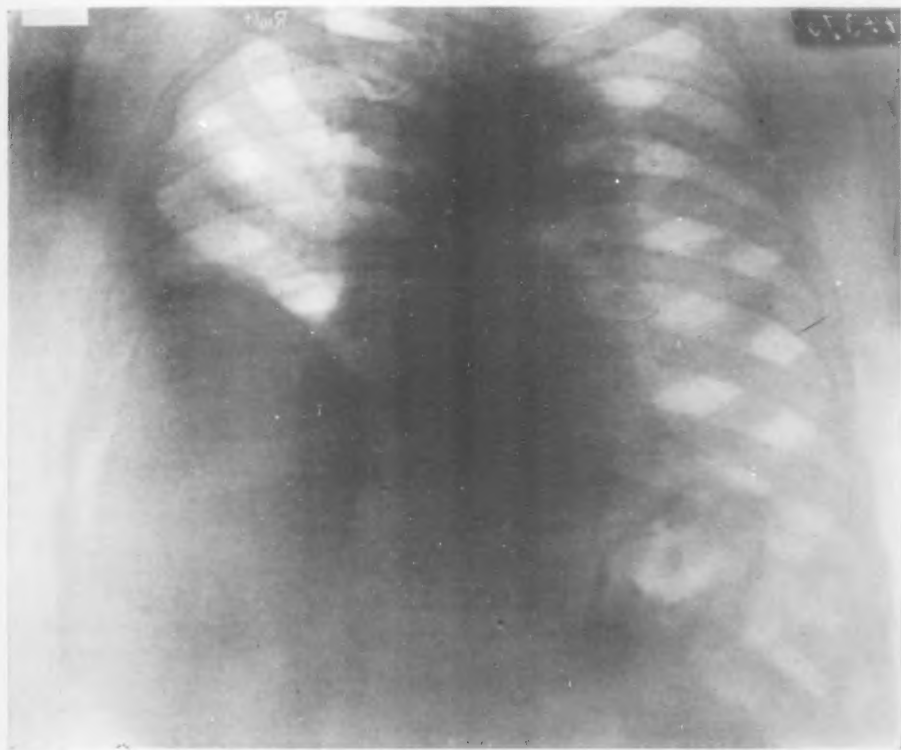

FIG. 1.—X-ray of Case I showing shadow of calcified cyst in right thoracic cavity.

of the contents of this shell gave us no clue as to its nature. The patient remained in good health until 1921, five years after operation, when he entered the hospital on the medical service with myocardial insufficiency. Physical and X-ray examination at that time showed some retraction of the right chest, slight thickening of the pleura and dilatation of the heart and aorta. At the present time (August 20, 1923) he reports that he is in good health.

CASE II.—The second case is one of recurrent *osteochondrosarcoma* of the tenth rib involving the pleura.

A girl, aged fourteen years, was first admitted to the Johns Hopkins Hospital, April 21, 1919, complaining of a tumor over the tenth rib in the posterior axillary line. The tumor was about 6 x 3 cm. in diameter, was firmly attached to the rib, was of stony hardness and slightly tender. A diagnosis of sarcoma of the rib was made, and on

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April 29th, Dr. M. R. Reid resected a portion of the tenth rib with the tumor mass. The posterior periosteum was removed. The pleura was not interfered with. Examination of the tumor in Bloodgood's laboratory showed an osteochondrosarcoma. The patient left the hospital with her wound completely healed.

Two years later the patient returned to the hospital with a recurrent tumor attached to the proximal end of the resected tenth rib. The mass was about as large as on her previous admission. The skin over the tumor was freely movable. X-rays of the thorax (Fig. 4) showed marked destruction of the rib over a distance of 6 cm. No involvement of the other ribs was discovered.

FIG. 2.—X-ray of Case I in the erect posture, showing the fluid level.

The second operation was performed June 27, 1921. The skin was widely freed over the tumor. The ninth and tenth ribs were divided well behind and in front of the tumor. The intercostal muscles and pleura were divided at the same level and a large rectangular mass of tissue, including tumor, portions of the ninth and tenth ribs, intercostal muscles and pleura, were removed.

This left a large defect in the thoracic wall about 15 cm. long and in width corresponding to two ribs and three intercostal spaces. With the production of such a large opening in the thoracic wall there occurred a definite respiratory upset with cyanosis and tachycardia. The lung was quickly drawn into the opening and held there until we had decided what form of plastic procedure to use to close the opening. The diaphragm seemed the only available structure, and therefore it was drawn up to the opening and sutured to its margins. The skin was closed tightly.

Post-operative convalescence was uneventful. The lung quickly expanded. The patient was discharged apparently well. At the present time (August, 1923), two years after operation, she is without evident recurrence.

Comments.—The interesting feature in this case was the use of the diaphragm to close a large defect in the thoracic wall.

The opening was too low to make satisfactory use of the latissimus dorsi muscle, but not too high to make use of the diaphragm. There was no evidence at the time of the patient's discharge that the diaphragm had pulled away from its place of attachment. The respiratory upset, which occurred with simple ether anæsthesia, was not serious, yet was sufficiently disturbing

to make it seem advisable to have at hand some form of pressure apparatus in subsequent operations.

CASE III.—The third case is one of intrathoracic, extrapleural *xanthoma* or *xanthosarcoma*, the first xanthoma, so far as I can learn from the literature, to be reported in this locality.

The patient, a physician, aged twenty-nine years, had for fourteen years pain of a cramp-like nature in the right lower quadrant. The pain was not associated with fever or nausea; nevertheless, in 1911, on the advice of his physician, he had his appendix removed. The appendix was normal and its removal failed to relieve his pain. During his service with the army in France the pain became more severe and he was repeatedly examined. A relaxed inguinal ring with an impulse was noted and a hernia operation was suggested but refused. Cystoscopic examination, catheterization of the ureters and thorium injections of the renal pelvis with X-ray examinations failed to discover any abnormality. X-rays of the gastro-intestinal tract were negative. He continued to have pain in his lower right quadrant, but in addition began to have severe pain in his back which was called lumbago. In November, 1918, he had in fluenza and an X-ray of his chest showed a mass behind and to the right of his heart shadow. Subsequent X-rays confirmed this finding. He was explored with a needle, but the exploration was negative. On his return from France he was given radium treatment in Baltimore,

FIG. 3.—Photograph of calcified cyst. The defect in its wall represents the area over which it was attached to the pericardium and great vessels.

but without benefit. His physical examination was negative except for the tumor shown in the X-rays (Figs. 5 and 6).

Operation was performed October 15, 1919. A long incision was made over and parallel with the ninth rib. The proximal six inches of this rib were resected and the parietal pleura stripped from the thoracic wall over a wide area. Without opening the pleural cavity the tumor was exposed. It was larger than a hen's egg, lay against the bodies of the vertebræ and seemed attached to the tenth rib. The pleura was readily separated from it. Having freed the tumor down to its apparent attachment to the ribs, portions of the tenth and eleventh were resected and removed with the attached tumor. The operation was completed without at any time opening the pleura. The wound was closed without drainage.

Post-operative convalescence was uneventful with the exception that the extrapleural space filled with fluid which, however, subsequently disappeared. The wound healed *per primam*. The patient is perfectly well and free from pain four years after operation.

Comments.—The most interesting feature of this case is the nature of the tumor (Figs. 7 and 8). It is a typical xanthoma and the first, I think, which has been reported within the bony thorax. Its origin is uncertain. Its only point of attachment was apparently the tenth rib, but examination after the removal of the tumor showed that this attachment was not to the bony rib and not precisely to the periosteum. At least the attachment was not such that the tumor could be said to arise from the periosteum.

A second interesting feature of this case was the extrapleural approach
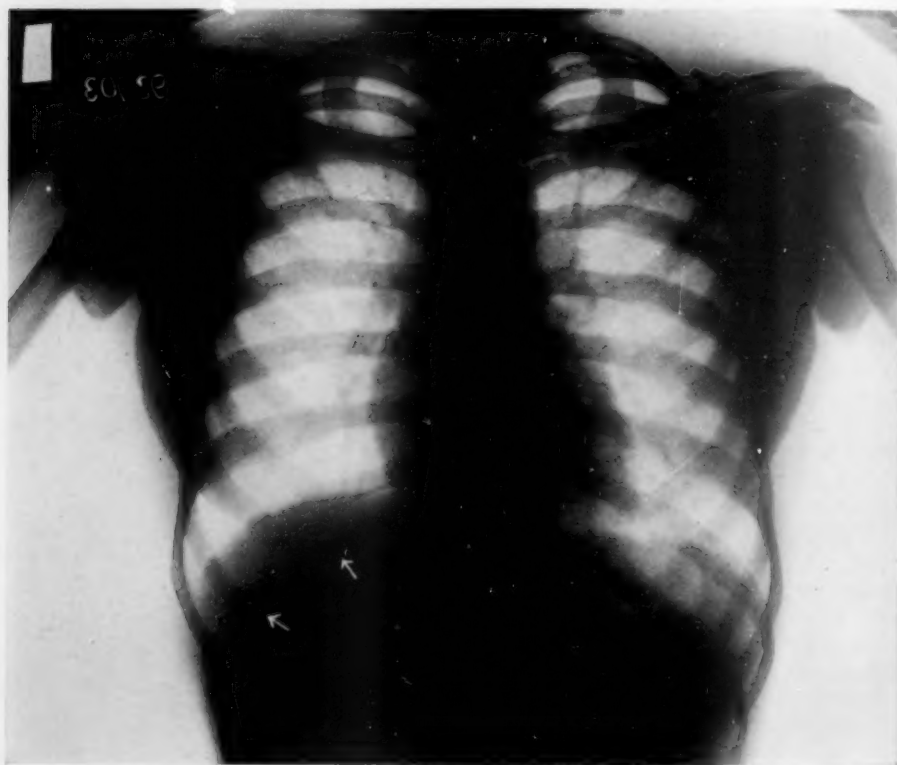
FIG. 4.—X-ray of Case II. The arrows point to the area of destruction in the rib.

and the removal of the tumor without opening the pleural cavity. It has been found in approaching thoracic lesions that stripping the parietal pleura has a number of advantages. It permits through the resection of a single rib a wide exploration of and an approach to lesions before the pleura is opened. It enables one to determine where, if any, adhesions between lung and pleura exist. In all the cases reported in this series it has proven to be a useful procedure.

CASE IV.—The fourth case is one of *chondromyxoma* or *benign cyst* occupying the upper half of the right thoracic cavity and arising presumably from the costovertebral articulations of the fourth and fifth ribs.

The patient, a man, aged forty-seven years, was admitted to the Johns Hopkins Hospital, November 13, 1920, complaining of pain in the right upper thorax and cough

with bloody sputum. Six years before admission he began to have pain in his right upper thorax and under his right scapula. About the same time he developed a cough which was thought to be due to pleurisy. There followed attacks of fever, increased pain, cough and hoarseness which put him to bed three or four times a year for periods of three or four weeks. A year before admission he had during one of these attacks a profuse hemorrhage from his lungs and was seriously ill with a high fever and delirium. After convalescing from this attack he was sent to Saranac, where he remained six months and where repeated sputum examinations failed to show any tubercle
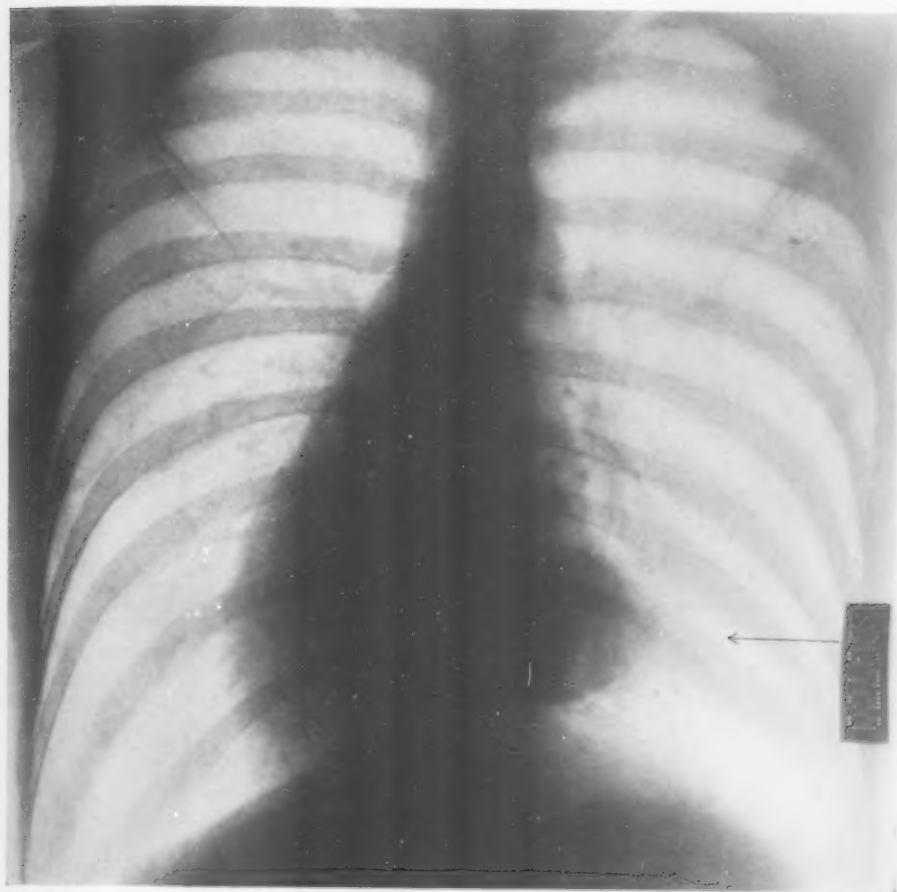
FIG. 5.—X-ray of Case III. Antero-posterior view showing the shadow of a tumor to the right of the cardiac shadow.

bacilli. A needle was inserted into his chest and blood obtained. During the year before admission he had become increasingly more dyspnœic and had lost weight.

Examination showed immobility of the right upper thorax, dulness on percussion extending down to the second rib in front and the fourth spine behind, and diminution in the breath sounds. X-ray plates of the chest (Fig. 9) showed a large mass occupying the upper half of the right thorax. A diagnosis of a benign new growth was made with the supposition that it was a dermoid cyst.

Operation was performed November 18, 1920. Under simple ether anæsthesia an incision was made anteriorly over the fourth rib from the right sternal margin to the anterior axillary line. The fibres of the pectoralis major were separated and about six

inches of the fourth rib resected. The parietal pleura was stripped from the thoracic wall over a fairly wide area. Beneath it the lung was seen moving freely, and on palpation through the thin layer of lung tissue there could be felt a large, firm mass. The parietal pleura was therefore incised and the thin film of lung tissue freed from the presenting surface of the tumor. The lung was but slightly adherent to the mass and could be readily freed from its surface. After about half the mass was freed it presented itself as a spherical tumor as large as a grapefruit, filling almost the entire upper one-third of the right thoracic cavity, definitely fluctuant on palpation and with a

Fig. 6.—X-ray of Case III. Lateral view showing the shadow of the tumor against the spine.

grayish-yellow wall in part calcified. On continuing the enucleation of the mass the lung was found to be adherent in one area, and here the wall of the mass was ruptured. There escaped a gelatinous myxomatous material, and thinking that the removal of this might help us in our further efforts, we deliberately incised the wall of the mass and removed large quantities of this sticky material. Inserting our hand within the mass we found the posterior half of it filled with aborescent masses of calcified tissue, which converged to a hard, bony mass fixed to the posterior thoracic wall. Returning at this point to the enucleation of the now collapsed wall of the tumor we freed it posteriorly to a point where it converged into the bony mass just described. This mass was most firmly united to what was taken to be the fourth and fifth ribs at their junction with the

Fig. 7.—Case III.   Painting by Mr. M. Brödel, of the cut surface of the tumor (xanthoma) showing areas of yellow pigmentation.
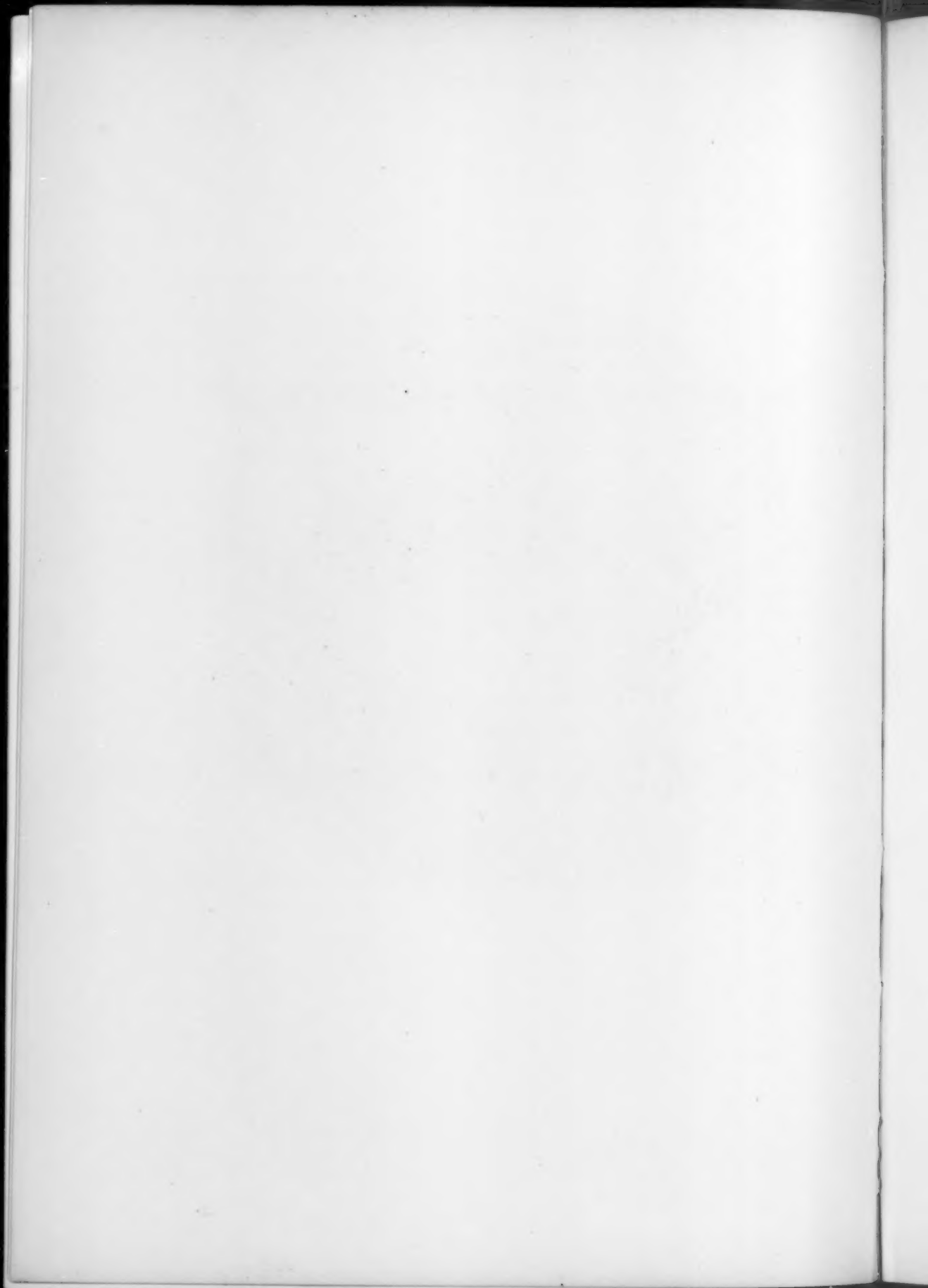
vertebral column. It was freed from its attachment with rongeurs and the entire wall of the tumor removed.

There was practically no bleeding throughout the procedure, and there was not at any time any respiratory disturbance or cyanosis. The wound was closed without drainage. The patient was considerably shocked at the end of the operation and his pulse was about 150. His color, however, was good and we felt no particular anxiety about his condition. Suddenly, about an hour after operation, he gave a few gasping respirations and died. An autopsy was not obtained.
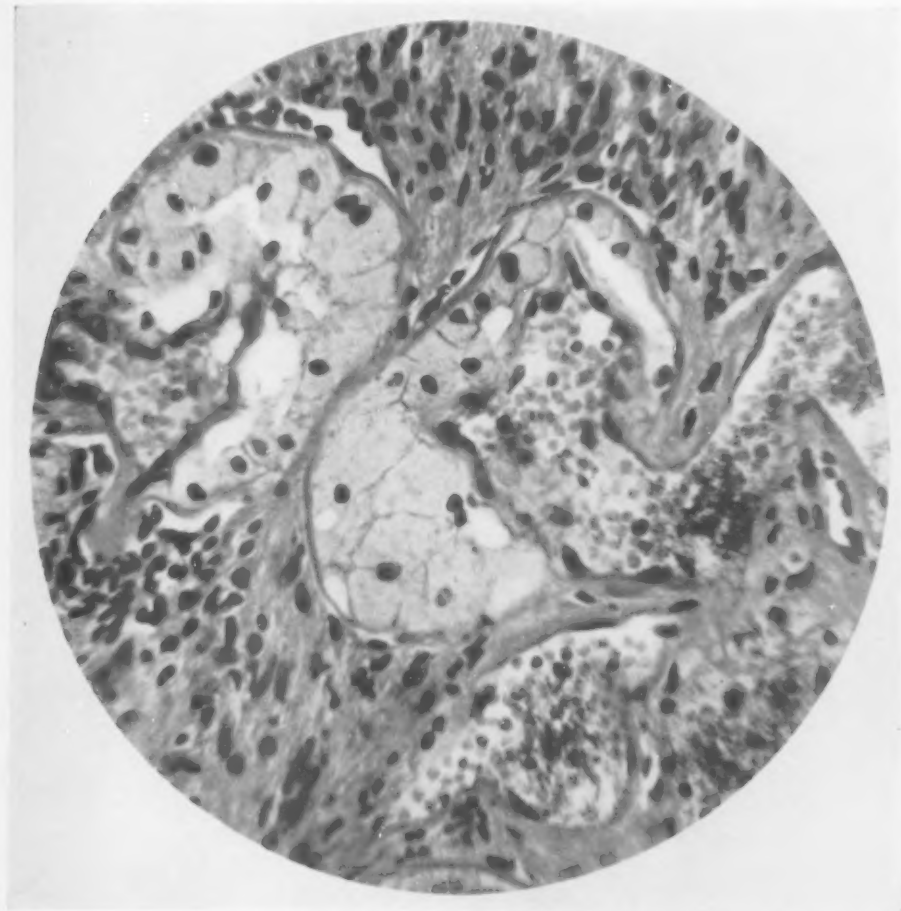
FIG. 8.—Case III. Microscopic section of xanthoma showing groups of "foam" cells.

Comments.—It was indeed hard to lose the patient after the removal of what was evidently a benign lesion. The nature of this tumor to my mind is in doubt. Bloodgood examining various portions of its wall concluded that it was a benign cyst resulting from a hemorrhage due to tuberculosis, with the organization of a hæmatoma and ossification of its wall. Against this diagnosis was the clinical appearance of the tumor at operation and the fact that it was entirely extrapulmonary and I believe extrapleural. No connection with the lung could be determined at operation nor the source of the previous

hæmoptysis. The tumor had no connection with the mediastinum and there-
fore a dermoid can in all probability be ruled out. Our own opinion, based
largely upon the findings at operation, is that the mass was a myxochondroma
arising from the posterior thoracic wall.

CASE V.—This is one of *pleural endothelioma*, possibly of *sarcoma*, arising in the
upper right thorax.

The patient, a man, aged thirty-three years, was admitted to the hospital, February

FIG. 9.—X-ray of Case IV, showing a dense, circumscribed shadow in the upper half of the right
thoracic cavity.

16, 1920, complaining of pain in his right chest. Five years previously he began to have
thoracic pain localized at first in his right axilla, later becoming more general. This
had gradually become more severe. Pain was the only symptom complained of until a
year before admission, when he developed a cough which has persisted. It was unaccom-
panied by sputum or hæmoptysis. Recently there had been some dyspnœa even on the
slightest exertion. In the five years of his discomfort he had consulted numerous

physicians, had many X-rays taken, all of which showed an intrathoracic tumor, and had tried a course of radium treatments in Baltimore without benefit.

Examination showed a well-nourished man with moderate dyspnœa, with limitation of movement of the upper right thorax and with dulness over the upper right chest in front and behind. To the right of the sixth dorsal spine over an area 3 cm. in diameter could be heard a fairly loud systolic murmur which was not transmitted from the cardiac area. X-ray examination (Fig. 10) showed a large intrathoracic mass which did not pulsate on fluoroscopic examination, and which was diagnosed a cyst or a sarcoma.
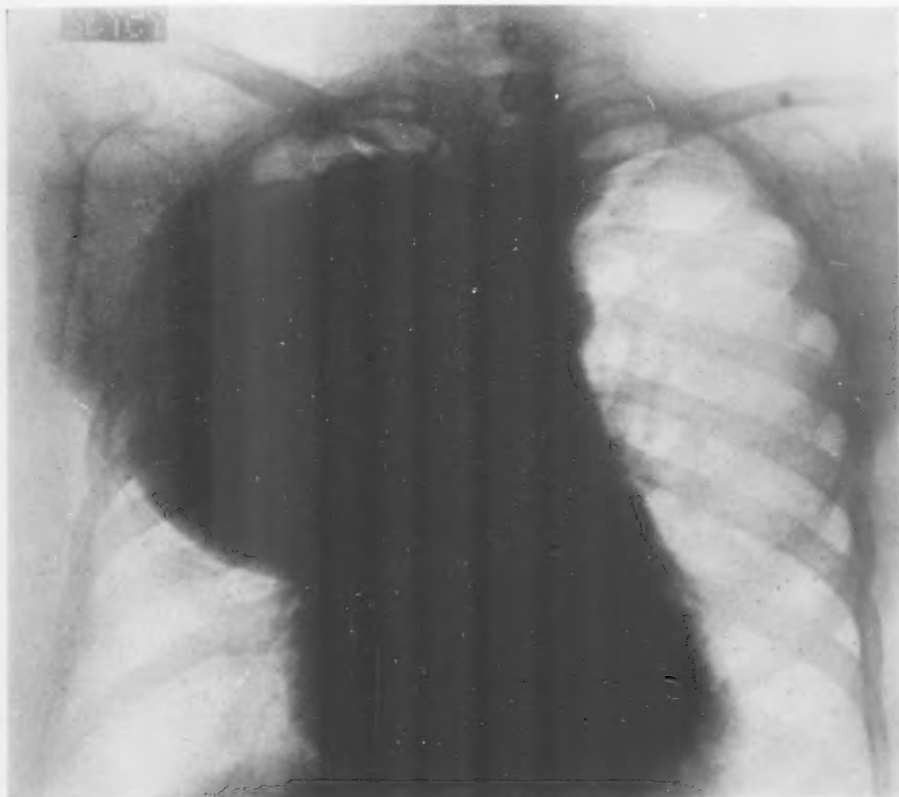
FIG. 10.—X-ray of Case V, showing a circumscribed shadow in upper half of the right thoracic cavity.

Operation was performed February 21, 1920, under simple ether anæsthesia. A T-shaped incision was made over the right thorax anteriorly, the horizontal leg extending from the sternal margin laterally to the axilla over and parallel with the third rib, the vertical leg paralleling the right sternal margin. The third rib was resected; the costal cartilages of the second and fourth ribs were divided at their junction with the sternum, permitting wide retraction with a rib spreader. The parietal pleura was stripped from the thoracic wall, this procedure allowing a still greater field for exploration. No adhesions between the lung and parietal pleura were seen. The pleura was therefore freely incised at a point of election and an attempt made to free the presenting portion of the upper lobe of the lung from the underlying tumor. Unlike the preceding case, this was an extremely difficult matter, due to adhesions between lung and tumor and to numerous thin-walled vessels, bleeding from which was quite profuse. Finally, however, after considerable effort and some loss of blood, about half of the tumor was freed. It was the size of a grapefruit, deep red, succulent, pulsating, almost fluctuant, and evidently

very vascular. It was immovably fixed apparently to the mediastinal structures and the posterior wall of the thoracic cavity. A large aspirating needle was introduced into the tumor and pure blood, which, under the microscope, showed no abnormal cells, was withdrawn.

In view of the size, vascularity and fixation of the tumor any attempt to remove it was abandoned. The wound was carefully closed without drainage. The patient made a prompt recovery from the operation, but pain naturally continued. Thinking that a thoracic decompression might aid both pain and dyspnœa, the patient was again subjected to operation.
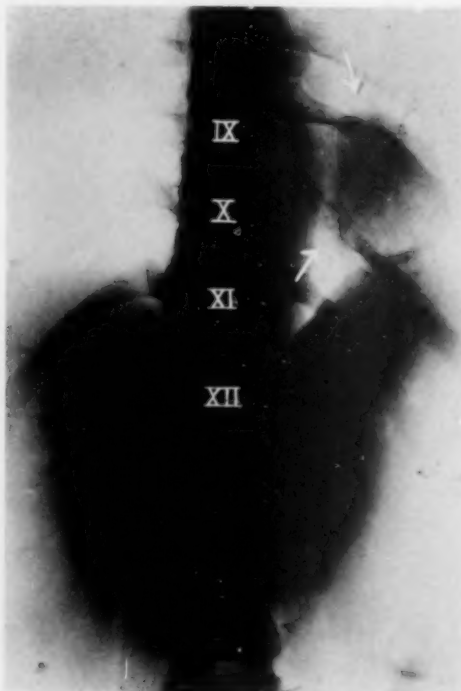
On March 13, about three weeks after the first operation, a long incision was made across the back over the course of the eighth rib. The lower angle of the scapula was reflected upward. Portions of the sixth, seventh and eighth ribs were resected, totalling 46 cm. The intercostal muscles of the sixth and seventh interspaces were excised. Immediately under the operative field was the tumor, which was under such pressure that when the ribs were resected the mass actually bulged through the operative opening. The pleura was incised and an attempt again made to determine the origin of the tumor. We could merely say that the mass was firmly fixed to the posterior thoracic wall and to the mediastinum. The mass was again aspirated and the material sent to the laboratory. The wound was closed without drainage.

The patient again made an uneventful recovery. The wound healed *per primam*. He was discharged from the hospital three weeks after operation, with marked improvement in his pain and dyspnœa. Some time after returning home, however, his pain and dyspnœa returned. A newspaper clipping received four months after operation stated that he had died.

FIG. 11.—X-ray of Case VII, showing tumor opposite the ninth and tenth thoracic vertebræ.

Comments.—The interesting features in this case are, first, the size and extraordinary vascularity of the tumor. As recorded in the history a bruit could be heard over it and at operation it definitely pulsated. The examination of the aspirated contents removed at the second operation showed large masses of tumor cells, the character of which suggested to Bloodgood an endothelioma or a sarcoma. MacCallum confirmed the diagnosis of endothelioma. A second feature was the satisfactory exposure of a large tumor by an anterior approach, first used, I believe, by Tuffier and Le Fort. By the resection of a single rib, combined with the division of the adjacent costal cartilages, an exposure was obtained which would have been adequate for the removal of this tumor. A third feature was the inadequacy of a decompression operation to relieve for any period the pain and dyspnœa. From the

appearances at operation, *i.e.*, the pressure exerted by the tumor upon the thoracic wall and necessarily upon the mediastinum and the herniation of the mass through the operative defect as occurs in cranial surgery, I had anticipated that this was an ideal case for a decompressive thoracotomy. Such, however, was not the case.

CASE VI.—This is a second case diagnosed as a *pleural endothelioma*.

The patient, a white man, aged forty-five years, entered the Johns Hopkins Hospital, December 7, 1921, complaining of a painful lump in his right side. He dated his illness from an attack of influenza three years previous to his admission. During this illness he complained of soreness under the ribs of his right side, which continued and increased after the attack of influenza had subsided. In August, 1921, he first noticed a small, painful nodule upon one of his ribs which gradually increased in size until at the time of his admission it measured about 6 cm. in diameter. The pain, which at first was local, later radiated to the pit of the stomach and around to the back. It had become so severe that the man was unable to work and could not sleep.

Examination showed a fairly well-developed although anæmic man. Near the right costal margin, inside the mamillary line, was a non-pulsating, hard tumor mass measuring 6 x 5 x ¾ cm. and apparently firmly attached to the seventh and eighth ribs. The skin over the tumor was freely movable. The X-ray of this region was quite negative. Examination otherwise showed old, healed tuberculosis of both spaces. A diagnosis of probable sarcoma of the ribs was made.

Operation was performed December 14, 1921, by Dr. Emil Holman, then resident surgeon at the hospital. A long incision encircling the thorax was made parallel with the seventh and eighth ribs. The superficial muscles overlying the tumor were divided. The deeper muscles were attached to the growth and were subsequently removed with it. On closer examination the mass appeared to penetrate the thoracic wall between the seventh and eighth ribs not to arise from them, and this observation was later confirmed. The seventh and eighth costal cartilages were divided at their junction with the sternum. An attempt was made to strip the parietal pleura, but this was unsuccessful, and the pleural cavity was widely opened. There was a monfentary respiratory upset and anæsthesia was continued with a gas-oxygen apparatus using positive pressure. On opening the pleural cavity the greater part of the tumor was found to be intrathoracic. It involved both leaves of the pleura in the costophrenic sulcus and was firmly adherent to the diaphragm. The bloc removal of the tumor required the wide resection of the seventh and eighth ribs, the resection of a fairly large area of the diaphragm and of the diaphragmatic and costal pleuræ. The diaphragmatic reflection of the peritoneum was exposed but not opened. The closure of the defect in the diaphragm was difficult, and as a result of the resection of this structure it could not be used in the plastic closure of the large opening in the thoracic wall, as in a previous case. Closure of the thoracic opening, however, was accomplished by use of the external oblique muscle, the rectus sheath and the anterior portion of the latissimus dorsi muscle.

Post-operative convalescence was uneventful excepting for a mild respiratory infection. The wound healed *per primam*. The patient was discharged from the hospital three weeks after operation, quite relieved of his pain and in excellent physical condition. A letter from his family states that he died ten months after operation.

The tumor on removal was about the size of a lemon. The pleura over it was attached and thickened. From the gross examination it could not definitely be said, in my opinion, that it arose from the pleura. Yet if it did not its origin is as problematical as is that of the xanthoma previously recorded. The microscopic diagnosis made in Bloodgood's laboratory was endothelioma of the pleura.

Comment.—The only unusual feature of this case from an operative stand-

point was the necessity of resecting the diaphragm. The closure of the defect proved to be unexpectedly difficult. Whether closure upon the right side is necessary is a question upon which we have very little information. Upon the left side, however, one would be unwise, I think, to leave a defect of any size even with an intact peritoneum.

CASE VII.—This is a third case diagnosed as *pleural endothelioma*.

The patient, a white girl, aged seventeen years, was admitted to the Johns Hopkins Hospital, October 21, 1921, complaining of a swelling upon her back. About eight
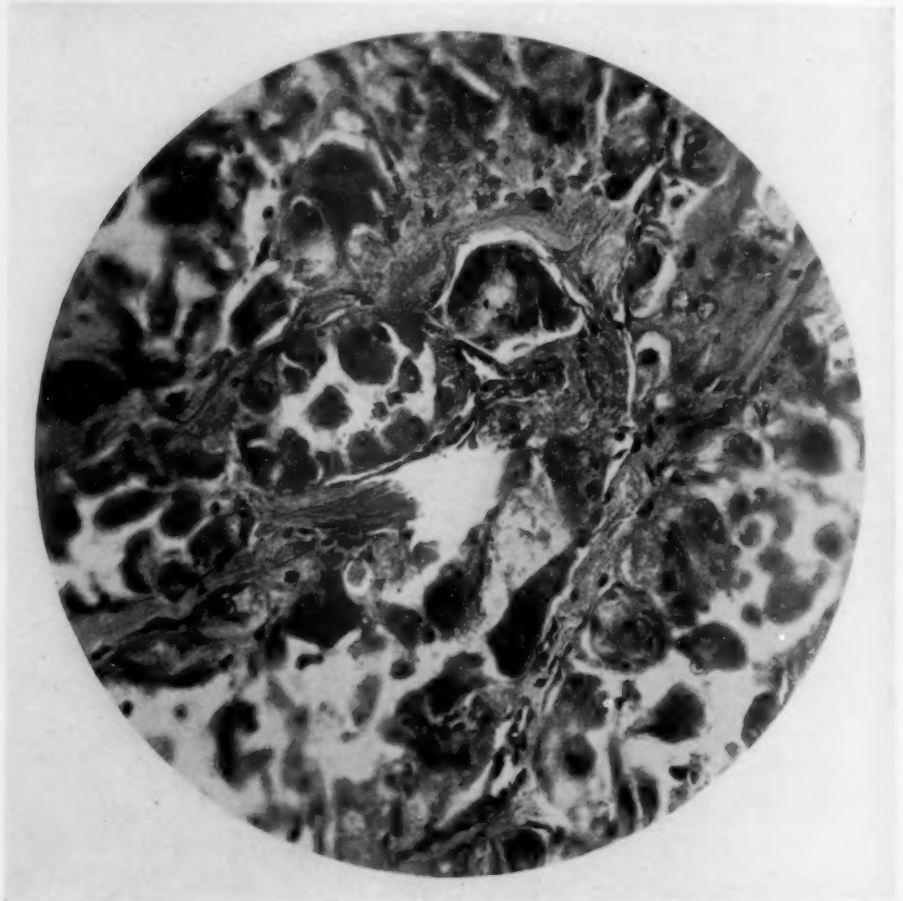
FIG. 12.—Microscopic section of the tumor removed from Case VII.

months before admission she noticed a small, painless lump just below the angle of the left scapula. Her family physician said it was a cyst and at first little attention was paid to it. The mass, however, increased rather rapidly in size and five months after its appearance became painful, the pain radiating up to the left side of the neck and around the left side. In the two months before her admission this pain had become so severe as to quite incapacitate her.

Examination showed a fairly well-nourished and well-developed girl in whom the only abnormality found, with the exception of the tumor to be described, was a well-compensated mitral insufficiency. Just below the inferior angle of the left scapula

was a swelling as large as a hen's egg. the skin over which was normal in appearance and freely movable. On palpation the mass was tense, gave the impression of fluctuation and pulsated with a definitely expansile pulsation. Over it could be heard a loud, systolic bruit. It seemed to be attached to the ninth and tenth ribs. X-ray (Fig. 11) showed a tumor mass and a partial destruction of the ninth and tenth ribs close to the spine. Baetjer, from the X-ray plate alone, suggested an acute infectious process. Futcher made a diagnosis of aneurism of the descending thoracic aorta and Baer thought it was a cold abscess with transmitted pulsation. A younger member of the surgical staff aspirated the swelling and obtained what appeared to be pure blood, but which when examined by Guthrie showed masses of tumor cells. A final diagnosis of intrathoracic tumor either endothelioma or sarcoma was made.

Operation was performed October 26, 1921, under simple ether anæsthesia. A large skin flap with its pedicle over the spine was reflected. The erector spinæ muscles over the mass were displaced mesially and laterally, a procedure which exposed the tumor still covered, however, with muscle tissue. The ninth and tenth ribs were exposed and divided well in front of the tumor and an attempt made to strip the parietal pleura. On approaching the mass the pleura was found adherent to it, therefore the pleura was freely opened and the tumor examined. It was the size of a lemon, was rather fixed to the ribs and vertebræ and had no connection with the aorta. The pleura over it was thickened and presented plaques and masses of tumor on its inner surface. The operation then resolved itself into the removal en bloc of the ninth and tenth ribs back to the spine, the tumor and the pleura. The removal of this bloc of tissue left a very large defect in the thoracic wall, which, however, could readily be air-tightly closed by a muscle plastic. The wound was closed without drainage. At no time was there any respiratory upset.

Post-operative convalescence in this case was complicated by the development of a hæmolytic streptococcus empyema. At the time there was in the hospital ward with the patient a considerable number of patients with influenza, and the patient herself developed a respiratory infection. Whether then the infection was introduced from without or from within is problematical. As soon as the diagnosis was made, aspiration drainage at a point below the operative wound was instituted and dakinization of the cavity begun. Fortunately, in spite of the intrapleural infection, the large operative wound healed *per primam*. She was discharged two and a half months after operation with her empyema completely cured. A letter dated August 30, 1923, two years after operation, states that she is in good health but has some pain in her side.

Comments.—An interesting feature in this case was the establishment of a positive diagnosis by the aspiration before operation of tumor cells. The method of diagnosis was, in Baltimore at least, first largely used by Dr. C. G. Guthrie, and has proven very helpful in doubtful cases. The post-operative empyema which developed was most unfortunate, but happily did not interfere with a satisfactory result. It serves to illustrate what we so thoroughly learned in war wounds, *i.e.*, that in case of a pleural infection following an intrathoracic operation it is unwise to drain through the operative wound, for to do so means in most instances an infection of the wound with the development of an open pneumothorax. A microscopic section of the tumor is shown in Fig. 12.

CASE VIII.—This is a case diagnosed by many before operation as a mediastinal tumor which subsequently proved to be a *retropleural aneurism of the descending thoracic aorta.*

The patient, a young man, aged twenty-nine years, was admitted to the Cincinnati

General Hospital, April 18, 1923, complaining of pain in his chest. He had been thoroughly studied in Baltimore and through the kindness of medical friends there had been sent to Cincinnati for observation and treatment. The history relates that while with the army in France, early in 1919, he began to have pain in the back which at first was localized under the right scapula. The pain came on spontaneously without known cause. It gradually increased in severity, radiated around to the front of the chest and was associated with hyperæsthesia of the skin about the right costal margin. Since its onset the pain has never disappeared and has gradually worn down the patient's resistance,
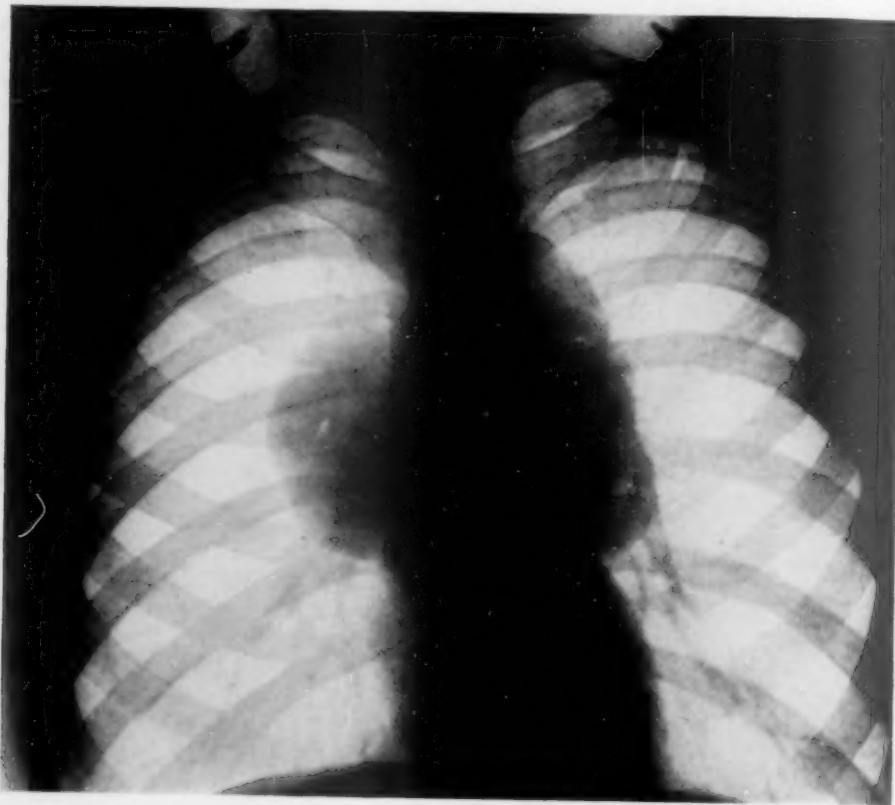
FIG. 13.—X-ray of Case VIII, showing the large centrally placed shadow in the thorax.

so that recently he has been quite incapacitated. There has been some dyspnœa on exertion. He has never had cough or expectoration. Since 1919 he has been, with the exception of short intervals, an inmate of hospitals in France and this country. He has repeatedly been examined, numerous X-rays and fluoroscopic examinations have been made and his Wassermann reaction has been repeatedly tested. All examinations have shown an area of dulness over the back, extending from the fifth to the ninth dorsal spines and 13 cm. to the right and 4 cm. to the left of the posterior median line. All X-rays have shown a large mass in the posterior mediastinum extending to either side of the midline. No observer has, so far as I can gather, seen this mass pulsate on fluoroscopic examination. One röntgenologist at Fort McHenry, Baltimore, suggested the diagnosis of aneurism, all other observers had made a diagnosis of mediastinal tumor. One Wassermann reaction was weakly positive, many others were negative. He has received an excessive amount of antiluetic treatment without avail, nor have deep X-ray therapy or radium treatments had any influence upon his symptoms.

Our own examination seemed to confirm those previously made. The same area of dulness over the back was found and stereoscopic X-ray plates (Figs. 13 and 14) showed a large mass rather centrally placed in the posterior mediastinum. Examined fluoroscopically the mass lay behind the base of the heart and did not pulsate. The ascending arch of the aorta could be seen displaced upward and to the right, and could be clearly differentiated from the mass by its pulsation. On swallowing bismuth the œsophagus could be seen curving forward in front of the mass. In view of our previous experiences we also made a diagnosis of tumor probably extrapleural and arising from the ribs or spine.

Operation was performed May 7, 1923, with intratracheal insufflation anæsthesia. A long, lateral incision was made over the right fourth rib extending from the posterior axillary line to the sternum. The fourth and fifth ribs were resected. Beginning posteriorly the parietal pleura was widely mobilized until the right lateral border of the mass was exposed. The mass was definitely extrapleural for the parietal pleura could be freed from its anterior wall. But the pleura was adherent and therefore was incised and the pleural cavity widely opened. The mass was of large size and lay behind the base of the heart, the descending arch of the aorta and the œsophagus.

It was unconnected with any structures in front but posteriorly was firmly fixed to the posterior thoracic wall and spine. Its presenting surface was smooth and grayish-yellow in color, not unlike the case of chondromyxoma previously described. The mass as a whole pulsated strongly. Fearing that after all the lesion was an aneurism, a con-

FIG. 14.—X-ray of Case VIII, lateral view showing outline of tumor behind the cardiac area.

siderable amount of time was expended in discovering the possible origin of the mass, and as a result of our efforts, we concluded that the mass fused with or blended with the descending aorta behind the base of the heart. My assistants, however, were not satisfied, and therefore we deliberately incised the mass, extruded some clots for examination and resutured the incision. There was no hemorrhage during the procedure. The examination of the clots failed to show anything but blood cells.

Not being prepared by our exposure to treat the aneurism at its source the operation was abandoned. The pleura was resutured and the wound closed without drainage. The post-operative convalescence was complicated by the formation of a bloody effusion which, however, disappeared after one aspiration. The wound healed *per primam*. For twelve days the patient remained in excellent condition, then suddenly after great pain he became pallid and there appeared a pulsating mass under his operative scar. He died May 19th.

Autopsy.—Retropleural aneurism of the descending thoracic aorta. Rupture of the aneurism along its right lateral border. Massive right hæmothorax. The communication between the aorta and the aneurismal sac was in the posterior wall of the aorta directly in the midline and measured 3 cm. in diameter. The sac extended retropleurally

to either side of the spine, but farther to the right than to the left. Its posterior wall was formed by the vertebræ which were markedly eroded and by the adjacent posterior thoracic wall. The incision made at operation into the anterior wall of the sac had healed. Rupture of the sac had occurred about 4 cm. from it at the junction of the anterior wall of the sac with the posterior thoracic wall.

Comments.—The case is included in this series because it demonstrates the difficulties in the differential diagnosis between some thoracic aneurisms and intrathoracic tumors. Two other cases in this series—both with expansile pulsation—were diagnosed wrongly as aneurisms. This case pronounced by many competent observers a solid tumor proved to be an aneurism. It is well known, of course, that aneurism of the thoracic aorta may not show visible pulsation under the fluoroscope. But in this case the age of the patient, the duration of the symptoms and especially the position of the mass were all against the diagnosis of aneurism.

Summary.—Of the 8 cases in this series 6 recovered from operation, 2 died soon after operation: 1 with symptoms of pulmonary embolism and 1 from the rupture of an aneurism. Of the 6 patients who recovered, 2 are living and well five or more years after operation and 2 are living and apparently well two years after operation. One patient died four months after operation unimproved by a decompressive thoracectomy, and 1 patient died ten months after operation from a recurrence of his disease. The lesions form a miscellaneous group and the diagnosis in a number of cases remains in doubt. The nature of one, a calcified intrathoracic cyst, remains problematic, as does the large tumor called by Bloodgood a hemorrhagic cyst, by me, a chondromyxoma. The sarcoma of the ribs, the xanthoma and the aneurism are sufficiently well established, but I am not so clear regarding the 3 instances of circumscribed encapsulated tumors called by our pathologists endotheliomata of the pleura. These tumors were first described by E. Wagner, later by Schulz, as extensive diffuse tumor formations giving rise to a markedly thickened pleura and associated with a bloody effusion. I have seen 2 such cases: 1 in Baltimore and 1 in Cincinnati. In both a thoracostomy had been done in the hope that drainage of the bloody effusion would relieve the pain and dyspnœa. In one the X-ray showed the entire pleura about three inches in thickness and in the other it showed a solid shadow due to the almost complete filling of the entire half of the thorax with tumor tissue. In none of the works on pathology which I have been able to consult do I find described the circumscribed encapsulated endotheliomata of the pleura such as we have had. Aschoff, however, in his classification of endotheliomata into hemangio-endothelioma, lymphangioendotheliomata and perithelioma states that the lymphangioendotheliomata may occur as circumscribed tumors, and it is possible that such tumors of the pleura may be analogous to those of the dura and pia-arachnoid.

TUMORS OF THE MEDIASTINUM IN CHILDREN

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AND

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The two following cases, occurring within a few days of one another, in the surgical service of the Children's Hospital, Boston, seem to be of sufficient interest because of their relative infrequency and obscure etiology to justify reporting them.

Case I.—Dorothy T., aged four and one-half years, admitted April 2, 1921.

Family History.—Father, mother and one sister are living and well. Mother had no miscarriages. There is no history of tuberculosis, carcinoma or insanity in the family. Both parents seem below normal mentally.

Past History.—Child was a full-term baby, normally delivered. Birth weight is not known. She was breast-fed for one year and did well. Since then she has been on a mixed diet. She has been below normal for the past two years, and was diagnosed as a case of malnutrition. She had four or five fainting spells last year. She has had no contagious diseases. On February 20, 1921, she had an acute illness with pain in the left chest and shoulder, some fever, and rapid and labored respirations. This subsided after ten days, but she never fully recovered. It was thought to have been pneumonia by family physician.

Present Illness.—The present illness dates from the acute illness in February. Dyspnœa has persisted since that time, with malaise, debility and malnutrition. On March 29 prominence of the left chest was noted in the region of the nipple for the first time. This increased steadily. There was no pain or cough. Loss of appetite, constipation, dyspnœa and malnutrition were present. Patient seemed drowsy.

Physical Examination.—The patient is a poorly developed and nourished child of four and a half years, of average mentality. The skin is dry, pale and scaly. The head is negative.

Eyes.—The right shows internal strabismus, and the pupil is larger than the left. Both pupils react to light and distance. The nose is negative. The mucous membranes of the mouth are normal. The teeth are in poor condition. No Koplik spots are seen. The right tonsil is enlarged and ragged. The neck shows no rigidity or retraction.

Thorax.—The left chest bulges prominently anteriorly, extending well towards the axilla. There is no obliteration of the intercostal spaces. The respiratory movements are restricted over the entire left chest. (See Fig. 1.)

Lungs.—The right side is hyper-resonant except where the heart impinges. Breath sounds on the right are positive. There are crackling râles in the right infraclavicular spaces. The left side is flat anteriorly to percussion in the axilla, dull in the back. Breath sounds are absent in front except at the apex and just below the clavicle, and are very distant in the back. Traubes space is dull.

Heart.—The impulse is felt on the right side in the fourth, fifth and sixth spaces. The right border of the heart is 10.5 cm. to the right of the mid-sternal line. The left

border is not determined. The sounds are regular and of good quality; there are no murmurs.

Abdomen.—The liver is 8 cm. below the costal margin. The spleen is not felt.

Extremities.—Normal. Reflexes: Normal knee jerks. No Babinski, or Kernig, etc. No ankle clonus. Glands: The right sub-mandibular glands are enlarged. Spine: Negative. Genitalia: Normal.

Diagnosis.—Question of empyema.

Hospital Notes. Blood. Red blood-cells.—Five million, six hundred and eighty-six

FIG. 1.—Case I. Lateral view, illustrating assymetry of chest, pre-operative.

thousand per cubic millimetre. Hæmoglobin: Eighty per cent. by Tallquist. White blood-cells: Thirteen thousand per cubic millimetre.

Von Pirquet.—Negative after sixty hours.

X-ray. Examination of Chest.—There is a definite shadow over the entire left chest except about the region of the heart apex. The right side also shows a shadow with ill-defined borders about the hilus. The shadow on the left side is very definitely mottled, with areas suggesting bone. Chest tap, 7th left interspace, 100 c.c. of thin

yellow fluid obtained with numerous small fibrin clots. Cell count 5000 per cm. Differential count, 71 per cent.; polymorphonuclears, 29 per cent.; mononuclears, few small (?) diplococci, without capsules are seen. No tubercle bacilli are noted. A few endothelial cells are present.

Urine.—Amber, cloudy, acid, 1032, no sugar, no albumin, sediment 5 mm., amorphous urates, no white blood-cells, reds or casts are seen.

April 4, 1921.—Chest cultures are sterile after forty-eight hours.

April 5, 1921.—Chest tap, 240 c.c. dark, brownish-red muco-purulent fluid.

April 6, 1921.—White blood count 17,600.

April 7, 1921.—Chest tap, 180 c.c. clear stringy fluid. Many white blood-cells, polymorphonuclears 96 per cent., lymphocytes 4 per cent.

April 8, 1921.—Fluoroscopy shows right side of diaphragm moves fairly, but left practically fixed. General condition of child shows no change, no pain; breath sounds come through slightly better following tap.

April 8, 1921.—Chest fluids all reported as sterile by Harvard Medical School Bacteriological Laboratory.

April 8, 1921.—Pathological laboratory reports fluid contains epithelial cells and a few fine hairs.

April 9, 1921.—Transferred to surgical service with diagnosis of dermoid cyst of the mediastinum.

April 12, 1921.—*Operation.*—Ether anæsthesia. Excision of tumor. Child lying semi-recumbent on the right side, the left arm drawn upward and forward. Incision made over the 7th rib from the mid-axillary line forward to the junction of the ribs and cartilages. Periosteum reflected and four inches of rib excised. The posterior layer of periosteum and pleura incised, found to come down onto tumor, which was not especially adherent anteriorly. Finger inserted, could sweep around tumor, breaking up delicate adhesions; edge of tumor found to be fairly well encapsulated. Incision then carried upward through costal cartilages to the third rib. The flap of chest wall thus formed turned upward and hand inserted into chest sweeping around tumor. This was found to be rather densely adherent posteriorly and toward pericardium—elsewhere it was fairly free. It extended across the midline, reaching to the right of the bodies of the vertebræ to a slight extent. An attempt was made to evacuate some of the cystic contents of the tumor, but the cysts were too small and the tumor too solid to diminish its size. With great force the tumor was then dragged out of the chest and pericardial adhesions freed. Chest cavity was at once packed with gauze and swathe applied. Child put to bed in sitting position. Tumor measured 15 x 11 x 9 cm.; irregularly lobulated.

There was comparatively little hemorrhage. Shock very great. Child rallied well and in a short time was crying.

April 13, 1921.—Severe reaction, temperature elevated, pulse weak. Constant stimulation with camphor and caffeine given.

April 15, 1921.—Packing removed, practically no oozing. Temperature still high (102.5°), but pulse is better.

April 18, 1921.—Child definitely better, eating well. Chest cavity shows some tendency to " fill in." Secondary infection present. Daily dressings with rubber dam and adhesive to make valve out of chest flap.

April 27, 1921.—Marked improvement—appetite good—chest cavity reducing in size. Recovery now seems only a matter of time.

June 23, 1921.—Steady improvement, condition excellent, eats well, plays much of time, chest wound nearly healed, lung expansion nearly complete by X-ray. Negligible drainage. No cough. Is to be discharged to Wellesley Convalescent Home for a few weeks before going home. Re-admitted August 16, 1921, from Wellesley Convalescent Home. Has not done as satisfactorily as expected at Wellesley for the last three

weeks. The old skin incision is still open and draining pus rather freely. The edges of the wound show unhealthy granulations. Little or no expansion of left chest—resonance much diminished—distant bronchial breathing along posterior spine. No breath sounds heard in axilla. Diagnosis: Post-operative empyema.

August 20, 1921.—Not satisfactory, losing ground, no appetite, anæmic and apathetic. Temperature remains elevated, 102°.

September 1, 1921.—Temperature normal for first time, but general condition worse.

September 8, 1921.—Condition very poor; wound gaping, foul, discharging pyocya-
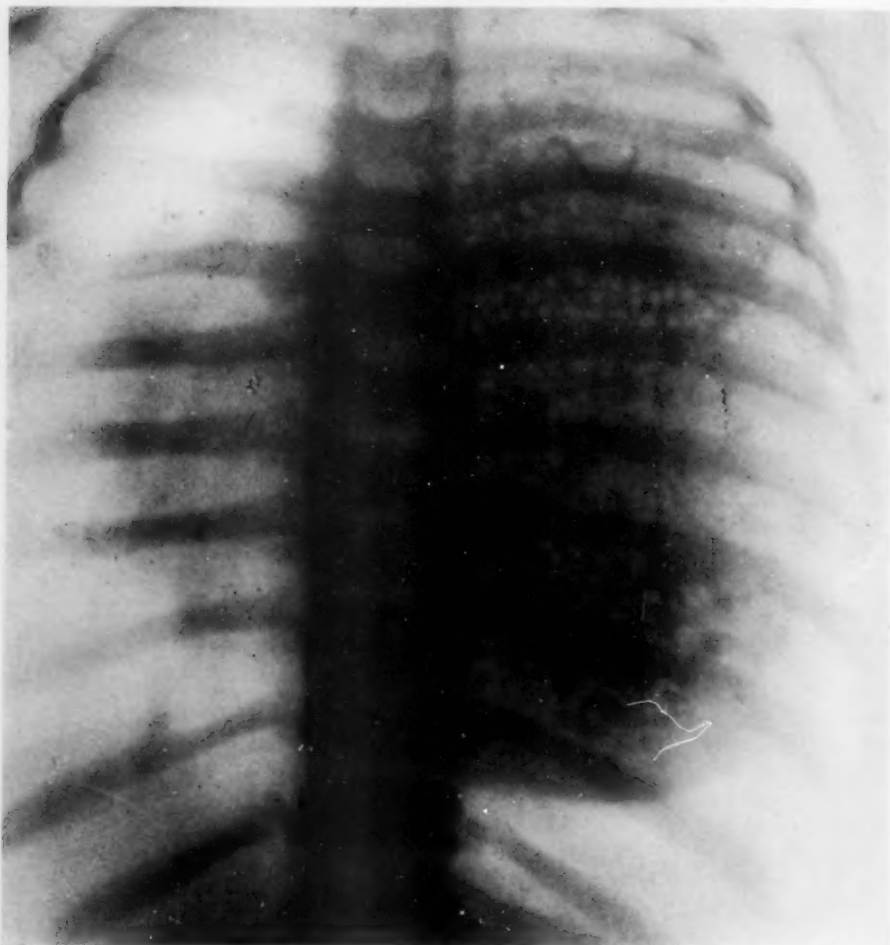
FIG. 2.—Case I. Radiogram of chest following aspiration showing size of tumor in relation to size of chest.

neous pus. Question of secondary KL infection raised. Three thousand units of antitoxin given intramuscularly. Heart action poor. Urine filled with pus, blood and casts. Question of secondary nephritis.

September 12, 1921.—This morning child appeared much worse. Pulse very poor. No result obtained from stimulation. While preparations were being made to take down the dressing the patient suddenly stopped breathing and all efforts to stimulate it proved ineffectual. Post-mortem examination not obtained. No evidence clinically of metastases.

Pathological Report.—The specimen consists of an irregularly lobulated, ovoid-shaped tumor, measuring in its greatest dimensions 15 x 11 x 9 cm. Its weight, after the escape of between 50 and 100 c.c. of blood-tinged myxomatous fluid from a ruptured cyst is 865 grams. The tumor consists of a large central mass with a slight constriction on its mesial aspect, suggesting an attempt at lobulation. There is no definite pedicle to the tumor. Mesially, however, overlying the constricted area just noted, are two thin layers of tissue lined with smooth glistening epithelium which formed the wall of the ruptured cyst and which were apparently attached by their lateral surfaces to the pleura or pericardium. Lining this cyst there is one definite papillary projection of epidermis, from which a tuft of fine hair about 1.5 to 2.0 cm. in length protrudes. The interior of the cyst is filled with a cheesy, fatty detritus which is still mixed with the somewhat slimy myxomatous fluid already noted. (See Fig. 3.)

Three or four smaller lobulated projections stud the main mass of the tumor, each presenting a somewhat rounded elevation varying from 1.0 to 2.5 cm. above the surface. These are of the same general appearance and consistency as the main tumor and on section show no particular differences warranting any separate description.

The whole tumor mass is surrounded by a dense capsule of connective tissue which is grayish in color, except where trauma and hemorrhage have caused a deposition of blood pigments into or under the protective layers of this capsule. The capsule, however, does vary considerably in its character and thickness. There are definite areas containing irregular plaques which have undergone calcification. These are indistinguishable from actual bone, and indeed one or two of these areas resemble very strikingly abortive attempts at true bone formation, with results not unlike slightly malformed rami of the hyoid. These plaques are found buried in the substance of the capsule, some scarcely palpable in the gross, others quite definite and of considerable size.

The blood supply of the tumor is apparently derived from capillary vessels entering the capsule, as no pedicle or hilus vessels are seen. (See Fig. 4.)

On cross-section the tumor is found to consist of a coarse framework of connective tissue, bone and cartilage, in which are embedded innumerable cysts varying greatly in size and character. It is relatively avascular, no vessels of noteworthy size being cut through. The cut surface presents a rather dirty, grayish-yellow appearance, which on analysis is seen to be due chiefly to the presence of a great deal of fatty brei in the cystic areas, and the presence of a black pigment similar in the gross to that seen in the choroid, which outlines a certain proportion of the cysts. There is likewise the presence of trabeculæ of blue-gray cartilage and bone which heightens this avascular, grayish color.

The most striking feature of the cut surface is the polycystic character of the tumor. These cysts vary in size from those scarcely discernible with the naked eye to those measuring 2 cm. in size, besides the larger one noted earlier. The average size is 2 to 5 mm. in diameter. These cysts are sometimes empty, sometimes filled with a honey-like, cloudy fluid, sometimes with mucoid, pale, translucent " jellied " material, sometimes with a fine yellowish, granular débris suggestive of cholesterin, often with a more frankly sebaceous material. Others present a mixed content. Certain cysts are multilocular—for the most part, however, they are monolocular.

Their surfaces are as varied as their contents: Certain of them are apparently lined with normal epidermis, some containing fine light brown hair, coiled up within the cyst and growing in tufts from papillary projections of the skin. Others are lined with a smooth epithelium resembling mucous membrane, others with chromatophoric tissue, identical in appearance with the choroid of the eye. Still others present papillary projections of mucous membrane suggestive of intestinal folds. The appearances are too manifold to be differentiated except under the microscope.

In the stroma there is likewise very little satisfaction in a gross description. There is a generous stroma made up apparently of connective tissue which has undergone differ-

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entiation into various of its derivatives, notably cartilage and bone and in the substance of which are embedded these multitudinous cysts and islands of other tissue, suggestive of ecto and mesodermal origin.

*Microscopical Examination.**—Microscopically the sections confirm the gross diagnosis of mediastinal teratoma. All three fetal germ layers are present, and there are obvious abortive attempts to form organs or parts of organs. There is no order about the arrangement of the tissues, neuroglia and striated muscle, epithelium and bone, side by side with no thought of function. Possibly the best way to study the sections is to take up the various derivatives of the entoderm, mesoderm and ectoderm. Almost any section studied will reveal on careful search nearly the entire variety of tissues described below.

Entoderm.—The entoderm is represented by various types of epithelium, which, while less prominent in amount, are no less important in establishing the final diagnosis.

(1) Mucous membrane with typical "goblet" cells occurring in single layers of columnar cells, or at times in a semi or completely stratified manner are noted frequently as lining many of the cystic areas. Certain of these latter are quite indistinguishable from the less characteristic single epidermis-lined cysts.

(2) Typical gastro-intestinal mucosa with the formation of rugæ of varying height is another feature which is one of the most striking microscopic pictures presented. In one area, as noted under mesoderm (5), there is a definite attempt to form a small portion of intestine which histologically most closely resembles duodenum. There is a definite lumen, a very characteristic mucosa, and loose connective-tissue submucosa, and two thick layers of smooth muscle, the inner arranged in circular fashion, the outer in longitudinal.

(3) Ciliated epithelium arranged usually in a pseudo-stratified layer, as in the trachea and œsophagus, is seen lining certain of the cysts. Occasional goblet cells are seen in their midst and the cysts are filled with a cellular, mucoid débris.

(4) Epithelium suggesting alveolar arrangement as seen in the lung is noted in a few places lining some of the cysts.

Mesoderm.—(1) Connective tissue in all forms is seen everywhere throughout the tumor, from the youngest undifferentiated, mesenchymal, spindle-like cell to the adult, elongated nucleus with its coarse fibroglia fibres and its dense collagen fibres. In places there are small areas where it has produced typical myxomatous tissue; in places the collagen fibres are nearly as densely packed as in a keloid. Again, elastic tissue fibres can be differentiated in places. In the adult form the fibroglia fibres similarly vary from fine to coarse, from short to long.

(2) Cartilage: The cartilage occurs chiefly in the embryonal hyaline form as trabeculæ or plates undergoing typical changes peripherally, with differentiation of the connective tissue, the formation of a hyaline matrix and the characteristic lacunar arrangement of the nuclei.

(3) Bone: The bone is about equal in amount with the cartilage, and similarly distributed generally throughout the stroma. It occurs apparently in both forms, primary periosteal bone with osteoblast and osteoclast activity and secondary enchondral bone which is the result of secondary bone replacement of the cartilage. There are also seen three or four small foci of so-called "osteoid" tissue where the arrangement of the tissue is similar to that seen in typical periosteal bone, but where calcification has not occurred.

(4) Blood-vessels: These are not a prominent feature, occurring chiefly as small capillary vessels. A few larger arteries with well-developed walls containing elastic fibres, and smooth muscle, are seen scattered here and there.

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* Tissues fixed in formalin, Zenker's and Kaiserling (gross specimen). Imbedded in paraffine. Differentially stained by the eosin, methylene-blue, hæmatoxylin-eosin, phosphotungstic acid hæmatein, Mallory's connective-tissue aniline blue, van Gieson's picric acid fuchsin, and Weigert's elastic tissue methods.

(5) Smooth muscle occurs in varying amounts, usually in the form of bundles scattered throughout the stroma, next to neuroglia or epithelial cysts, with no regard to function. In several instances, one, particularly noteworthy, in relation to entodermal gastro-intestinal tract derivatives, it is seen arranged in characteristic fashion in two or three alternately arranged layers of fibres, creating an unmistakable attempt at forming a functional bit of intestine. It is also seen in the vessel walls, around certain

FIG. 3.—Case I. Mediastinal teratoma, gross specimen (approximately three-quarter of actual size). Note tuft of hair on posterior wall of exposed cyst.

of the cartilaginous tissue much as seen in the bronchi, as well as scattered diffusely through the tissue.

(6) Striated (voluntary) muscle: This is a less prominent feature of the tumor, and is only found in certain of the sections. It occurs as single cells, and in bundles. The appearance of the individual cells is very much that noted in a typical microscopic slide of a case of " amyotonia congenita." The cells vary in size from short cells whose cytoplasm scarcely more than extends beyond the nucleus and contains but two or three striæ to great long cells as large and coarse as those of the gluteal muscles. Then there are all gradations between these—long, thin, incompletely striated cells, short,

thick, multistriated cells; cells which taper off to but one or two coarse fibrils, the termination apparently of the longitudinal striations, and other nondescript atypical cells with striæ which are incomplete.

This striated muscle occurs chiefly in a few small foci as if some embryonal myomere had been displaced and there were an attempt for it to develop normally. Again there is a group of fibres arranged more or less around the wall of a cyst lined with a pseudo-stratified ciliated epithelium.

Ectoderm.—(1) There are innumerable cysts of every possible size and shape, lined by as many types of epithelium. Possibly the most common, and on the average the largest, are lined by a stratified epithelium which microscopically presents the characteristic picture of typical epidermis with a deep stratified layer arising from a normal appearing generative zone of " prickle cells "—large cuboidal cells with intercellular bridges. There is the normal papillary downgrowth of the epithelium into the corium which varies markedly in its appearance. In places the differences between the atypical epithelium of ectodermal origin and the stratified mucous membrane of entodermal etiology is most uncertain.

(2) In addition, many of these cysts are complicated by having hair follicles and sebaceous cysts penetrating the underlying corium. These present normal histological characteristics.

(3) Other cysts lined by stratified epithelium contain definite coil glands in their picture. A few even present the mixed arrangement of sebaceous and sudoriferous glands, as well as hair follicles.

(4) Many of the larger cysts show marked desquamation of the horny layer of the epithelium into their lumina. This cornification may become so marked that even in the relatively deeper stratified layer there may be seen not infrequently the " epithelial pearls " so characteristically noted in epidermoid carcinoma.

(5) Again, there are many cysts lined by a single layered epithelium. These are apt to be rather smaller. Many of them are difficult to differentiate from the entodermal epithelium as it varies from high columnar to low cuboidal. The chief differential point probably is the absence of mucous " goblet " cells.

(6) One of the most striking things in the gross, which is corroborated by microscopic study, are the many cysts which are either partially or completely lined by a pigmented semi-stratified epithelium which appears in detail to be identical with that of the pigment layer of the optic cup. This impression is furthered by the contents of most of the cysts which are translucent and jelly-like—suggestively reminiscent of vitreous humour. These pigmented cells are seen occasionally in groups, possibly a portion of an adjoining cyst wall—but apparently lying independently in the stroma.

(7) Neuroglia is very generously distributed throughout the sections, usually in bundles of relatively coarse fibres, some consisting of but a few cells with their fibrils, others of great masses of tissue 1 mm. or more in diameter, lying with utter disregard of function close to bone, or epithelial cysts or intestinal mucosa.

(8) Nervous tissue: A few islands of rather characteristic brain-like tissue are noted with fine fibrillar material in which nerve cells with their dendritic processes are visible. Nothing which suggests cerebellar architecture however is noted.

(9) Nerves: Only a single cross-section of a medullated nerve trunk is noted in the sections studied. This has a characteristic sheath and runs in a mass of rather loose connective tissue.

(10) Ganglion cells: Several nests of ganglion cells are noted scattered very sparsely through the sections. These vary in number from three up to twenty-five or more. With the stains employed the Nisel granules are not well brought out, but can be seen to be present. Two of these groups of cells are in association with a mass of neuroglia fibres.

(11) Glands: Epithelial glands whose structure is identical with coil or milk

ducts are found frequently. When in association with epithelium of the skin type with hair follicles and sebaceous glands there is no difficulty in determining to which category they belong. Many of these glands with their inner lining layer of cuboidal epithelium and an outer layer of smooth muscle fibres occur free in the stroma, however, and there is no definite means of identification.

In conclusion then we may say that both the gross and microscopic examination of the tumor confirm in all respects the diagnosis of teratoma of the mediastinum. Derivatives of all three fetal germ layers are present in imposing array, thus differing

FIG. 4.—Case I. Cross section of tumor showing its multicystic character.

from the simple dermoid cysts which are composed only of epithelial derivatives with a connective-tissue stroma. In this tumor the organology is not as striking as reported in a few cases—no liver or pancreas tissue, no thyroid, no genito-urinary derivatives, no lymphoid tissues are noted. There is no attempt to form any extremities or head, but the whole is a confused picture of fetal cells growing wildly, irrespective of function. The impression of the tumor is one of a reticular stroma of connective tissue, bone and cartilage, in which can be found innumerable cysts of varying size and shape, lined by as many types of epithelium, and in the interstices of the stroma odd bits of fetal cell differentiation such as neuroglia, striated muscle and pigmented epithelium.

Diagnosis.—Mediastinal teratoma.

CASE II.—John H., aged twenty months, admitted April 5, 1921.

Family History.—The father and mother are living and well. There are no other children in the family and no miscarriages.

Past History.—The child was a full-term baby, with instrumental delivery. He was breast-fed for one year. He had chicken-pox at that time. There has been no other sickness until the present illness.

Present Illness.—The patient had pneumonia three months ago. His temperature was high for two weeks, when the crisis came. He has been "ailing" since with a slight temperature and loss of weight. The chest was tapped by the family physician twice and 21 ounces of fluid obtained.

Physical Examination.—Is essentially negative except for the chest. The child is moderately anæmic in appearance. On the left, expiration is diminished, and the inter-

costal spaces full, broadened, and bulging during expansion. The whole chest is flat on percussion. The breath sounds are very faint. Tactile fremitus is diminished. Grocco's triangle is present at the right base. The heart is pushed over to the right. The liver is pushed down with bulging of the chest outward and upward.

Hospital Notes.—Laboratory findings: Aspiration, red, thin, stringy fluid. No organisms are seen. Some cells are present. X-ray: A dense shadow in left lung area is noted, which thins out at the periphery. Temperature ranges from 98° to 101°. Blood: White blood count 19,600 per cu. mm. Von Pirquet: Negative after sixty hours. Wassermann: Negative.

April 7, 1921.—Child's condition is becoming worse rapidly. Tuberculosis has been ruled out fairly well. Another chest tap gives similar viscid fluid. The probability of malignant disease seems most likely diagnosis. From the operative point of view the case is hopeless.

April 8, 1921.—Another chest tap gives 23 ounces of similar fluid. X-ray plates immediately after aspiration show a series of shadows in left side of chest as if cast by some markedly lobulated tumor. Patient became very much worse and died in the late afternoon.

Autopsy.—John H., twenty months, fourteen hours post-mortem.

Anatomical Diagnoses.—Retro-pleural tumor, left, with extension to retroperitoneal tissue. Atelectasis of left lung. Myocardial hypertrophy. Congestion and œdema of the right lung.

Microscopical Diagnoses.—Question of papillary carcinoma of the left chest with metastases to the retroperitoneal tissues. Question of mesothelioma.

Body.—Is that of a moderately well-developed and well-nourished male infant. The most striking thing about the appearance of the body is a marked asymmetry of the thorax. This is substantiated by measurements, the right side of the chest in the nipple line measuring 23.2 cm. from the midline of the sternum to the spinous process of the vertebra, and on the left in a comparable plane measuring 25.7 cm. Likewise at the lower border of the ribs this is also most marked, the left lower ribs flaring out very markedly, while the right lower ribs are normal in appearance. The rest of the body presents no very striking features. The head is essentially normal in appearance. The pupils are equal and regular. The facies are not remarkable. There is no discharge from the ears or nose. There is no cyanosis of the lips or extremities. There is no general adenopathy. There is no œdema. The skin is clear except for a moderate post-mortem lividity in the dependent portions. There is no appreciable rigor mortis present.

The primary incision from top of sternum to pubes reveals a thin layer of normal appearing subcutaneous fat. The musculature is normal in color. On laying back the skin flaps the thoracic deformity is even more marked, but there is no apparent involvement of the ribs themselves as determined by an exterior view.

Peritoneal Cavity.—Contains a few c.c. of excess pale straw-colored fluid. The most striking features of the peritoneal cavity are obscured due to a low position of the diaphragm. The diaphragm on the right is attached along the seventh costal interspace. On the left it is attached along the superior border of the ninth rib, and its surface on the left is convex instead of presenting the usual concave appearance. It extends 3 cm. below the costal margin in its most dependent portion. Along the posterior attachment of the diaphragm there is a definite mass of tumor tissue which has infiltrated the diaphragm at that point and extended retroperitoneally into the abdomen. On the right the diaphragm maintains its concave relation, but it is distinctly lower in position than normal, and the entire liver as a result is displaced downward, measuring 9.5 cm. in the midline from the tip of the xyphoid and 7.5 cm. in the anterior axillary line. The left lobe of the liver is folded back on itself and is entirely to the right of the midline. This left lobe is atrophic in appearance, and soft in consistency. There is in the midline

and extending 3 cm. to the left of the midline a retroperitoneal mass of tissue just below the renal vein and in close approximation to the left kidney. This mass is drained by a large vessel emptying into the left renal vein, and over its surface the left spermatic vessels can be traced. There is no definite association of this mass with the suprarenal gland on the left. There are no peritoneal adhesions. The appendix is normal in appearance, retrocæcal in position. The pelvis shows no evidence of pathological changes. (See Fig. 9.)

Pleural Cavities.—The right pleural cavity contains no free fluid and no adhesions. The left pleural cavity is occupied by tumor mass which will be described, for the sake of coherence, at the end of the protocol.

Pericardial Cavity.—The pericardial cavity contains no excess fluid and no adhesions. The heart and its pericardium are displaced to the right and are overlying the right lung to a marked degree, the right border of the heart being 2 cm. to the right of the right anterior axillary line.

Heart.—Weighs 57 grams. Its epicardium is normal in appearance and contains a moderate amount of fat. The coronary vessels are normal in appearance. The myocardium is somewhat pale and slightly hypertrophied in relation to the size of the infant, this

FIG. 5.—Case I. Low power photomicrograph of abortive intestinal formation showing mucosa and double layer of smooth muscle.

hypertrophy being largely in the left ventricle. The endocardium is smooth and glistening throughout. There are no valvular defects, and no congenital anomalies.

Thymus.—Is present as a discrete gland, and is normal in appearance. It is readily dissected from the pericardium and the great vessels, and shows no association with the tumor.

Right Lung.—Weighs 112 grams. Its pleural surface is smooth and its appearance in the gross suggests no pathological changes beyond a slight congestion and œdema, due largely to mechanical conditions.

Left Lung.—The pleural surface of the left lung is infiltrated by tumor tissue, which has not definitely invaded the lung substance. The abdominal and pelvic organs present no lesions.

Left Thoracic Cavity.—On removing the sternum, a striking picture is presented of the left lung which is greenish-gray in color and completely atelectatic in appearance, being displaced forward and upward in the left chest by a large mass of tumor tissue, apparently retro-pleural in origin. Posterior and lateral to the lung tissue, there is a mucinous appearing hemorrhagic exudate which fills a considerable portion of the thoracic cavity. This fluid is filled with fragmented bits of soft friable necrotic tumor tissue. The tumor itself consists of about a half dozen large nodular masses which invade the thoracic cavity, remaining apparently retro-pleural for the most part. These masses, on section, all present about the same gross characteristics. They are grayish-white in color, but so largely necrotic and infiltrated with hemorrhage that they are usually rather
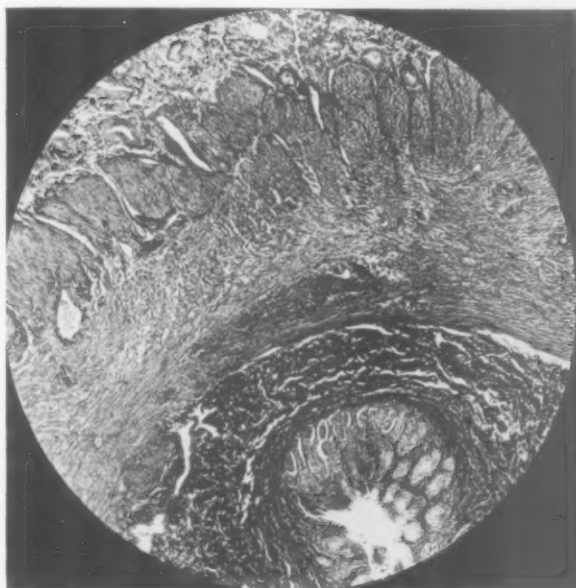
more reddish-gray in appearance, although certain small portions of the tumor do maintain their true color and characteristic nodular arrangement. The entire mass is exceedingly friable and difficult to remove without breaking up. It is firmly adherent to the chest wall from the angle of the scapulæ to the sternal border. After removing the main portion of the tumor there is still found to be a layer of tumor tissue firmly adherent to the periosteum of the ribs and the intercostal muscular fasciæ, which cannot be completely removed except by dissecting off the periosteum. This mass of tumor tissue gives the characteristic grayish-white appearance, not unlike cottage cheese in consistency. The tumor has invaded, as already noted, the diaphragm, and extended to the retroperitoneal tissue, where there is a large nodule of the same gross characteristics and appearance. The mesenteric lymph-nodes are somewhat enlarged and firmer than normal. They do not resemble characteristically the tumor tissue, but suggest the possibility of lymphatic extension. There is no obvious etiology of the tumor mass, and frozen section through a characteristic fragment suggests an embryonal character, the origin of which must remain uncertain. The tumor does not present any definite involvement of the mediastinal tissues. The lymph-nodes on section show no definite involvement. The great vessels are merely displaced laterally and are not involved in the tumor tissue. The sternum contains likewise on its posterior surface a similar tumor nodule which is adherent to the periosteum. At no point, however, does there seem to be involvement of the bony substance of the sternum, ribs or vertebræ.

Microscopical Examination, Heart.—Microscopically shows only moderate pathological changes, chiefly a slight œdema. There is no necrosis. There are no metastases of the tumor to the heart. The epicardium and endocardium show no pathological histological changes.

Lungs.—The right lung microscopically shows a marked œdema and congestion. There is no evidence of infection secondary to this process, however. The alveoli are largely filled with a serous exudate which on section shows as a fine pink-staining coagulum. The alveolar walls are not thickened. The capillaries are dilated and distended. The bronchi show no involvement. The left lung presents a picture of complete atelectasis. There is no evidence here of infection, and no evidence as yet of disturbances of the blood supply. The pleura is definitely involved in the tumor formation which has not, however, invaded the lung tissue. The tumor will be taken up separately at a later point in order to maintain the continuity of the description.

Thymus.—Is somewhat atrophic, the fibrous tissue interlobular septa being extremely prominent and somewhat œdematous. The lymphoid element is slightly diminished in amount in relation to the number and size of the Hassal corpuscles. The latter are prominent, numerous, and vary greatly in size. There is marked phagocytosis present. No other points of particular note.

Tumor.—Sections taken through the tumor nodules all show the same striking and unusual histological picture, that of a papillary cysto-carcinoma. The tumor is so extremely necrotic that large areas in many sections taken through this material, show nothing but a semi-necrotized mass of undifferentiable material in which there have been deposited coarse fibrin strands and a polymorphonuclear exudate which is attempting to phagocytize the necrotic material. There is a schizotic background in which one can detect the elements of a stroma, composed of loose myxomatous connective tissue and a generous vascular system. The tumor tissue itself, when well preserved, presents the picture of more or less indefinite alveolar structure, lined by a rapidly proliferating epithelium which grows in papillary projections, sometimes so extensively as to practically occlude the lumen. In other places, the projections are less marked in extent and merely appear as small papillary buds into the lumen. These epithelial cells grow usually as a double layer of epithelium, with a fine connective-tissue stroma supporting them. Certain of the papillary projections measure several mm. in length, and they branch in almost mycelial fashion. Some of the papillæ have a cluster of cells at

their termination, much as a bunch of grapes. Others are more finger-like in their appearance, while the majority of them arboresce in the most profuse and prolific manner. The histology of the individual cells under the high power is that of an ordinary rapidly growing, relatively undifferentiated epithelium with large round or oval nuclei which are relatively deep-staining and contain one or more nucleoli and a generous amount of coarse granular chromatin material. The cytoplasm of the cells is relatively slight in amount for the most part, extending as a narrow rim around the cells, and somewhat paler in color, staining a light bluish-purple with eosin, methylene-blue stain. Others
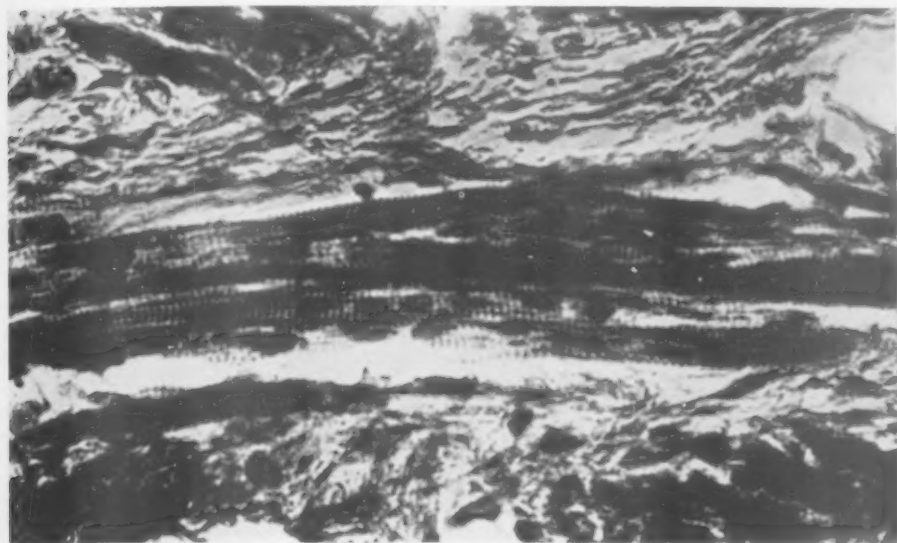

FIG. 6.—Case I. High power photomicrograph illustrating striated muscle occurring in unrelated bundles in tumor.

possess more cytoplasm, which appears vacuolated, with what are apparently fat droplets within them. In the intercellular spaces there are many mononuclear phagocytic cells which are engulfing fragmented tumor cells and whatever particulate matter is present. The necrotic cells appear as pale, pink-staining, relatively homogeneous cells with their nuclei in various stages of degeneration, from small dark pyknotic fragmented nuclei to large, swollen, pale-staining karyolytic nuclei. The cells have in their normal condition a definite cell outline, but it is largely lost in the necrotic masses. Nuclear figures are abundant, seldom less than three or four per high power field. They are rather striking in that their chromosomes are short, thickened, and frequently almost club-shaped on their ends. Occasional multiple mitoses can be seen. The arrangement of the tissue suggests the appearance of choroid plexus to a rather striking degree.

The stroma of the tumor is made up of a connective tissue which varies in its appearance in different portions of the tumor. For the most part it occurs as fine strands of adult connective tissue in which collagen fibres are relatively dense and adult in appearance. These connective-tissue cells frequently occur in bundles which on cross-section strongly resemble smooth muscle, but by differential staining it is apparent that no smooth muscle is present. In other areas of the tumor the stroma is less adult in appearance, and is myxomatous in character. The stroma is very largely œdematous, and in this œdema there is a moderate precipitation of fibrin in a fine reticular arrangement, in the meshes of which red cells and leucocytes of various types can be seen.

In some sections through the tumor the stroma approaches the embryonal type of mesenchyma, and there is a rapid proliferation of this young connective tissue, whose

nuclei are round to oval and distinctly undifferentiated. Also in this œdematous type of tissue there is prominent precipitation of the serum albumins in fine granular form. This extends frequently into the lumina of the tumor alveoli, where also areas of hemorrhage can occasionally be noted.

Sections taken through the atelectatic lung and its superficial pleura show the relation of the tumor to the lung and pleural tissues. It has definitely involved the pleura, thickening it and largely obliterating the pleural endothelium, and occurs in the same papillary adenomatous fashion, but never invading or destroying the lung tissue itself. Likewise the tumor is found to have perforated the diaphragm, and nodules can be seen in the substance of that muscle similar in structure. It is also adherent to the periosteum of the ribs, but has not infiltrated the ribs themselves, nor invaded, except superficially, the periosteal tissue. There is no evidence of metastases elsewhere, except as noted in the gross description by direct extension to the retroperitoneal tissues. There is no obvious etiology for the tumor, nor can one do more than hypothecate in regard to its source. The possibility of ectodermal rests from branchial cleft inclusions (thyroid, thymus, etc.,) must be considered. The possibility of a pleural mesothelial origin cannot be ruled out. The one-sided development of a teratomatous embryonic tumor of blastomere origin likewise must be considered, in spite of the lack of evidence of any other tissue being present.

Tissues are hardened in formalin and Zenker's, and stained by routine eosin, methylene-blue; with phosphotungstic acid hematein; Mallory's connective-tissue stain, and Van Gieson as differential stains.

Clinical Discussion.—These two cases present so much in common and are both so unusual that a brief discussion of a few of the more outstanding features seems pertinent.

In the first place, the family history in each instance is entirely negative. There is nothing on careful questioning to suggest even remotely an hereditary etiology. In neither past history is there anything of importance bearing upon the development of the tumor. The second case is in a child so young as to practically preclude any possibility of earlier infection as an activating factor in starting the malignant degenerative changes of the pleural cells, and in the first case there is nothing of an infectious or traumatic character to suggest an early etiology.

Both cases date from an acute onset, simulating pneumonia, and very probably brought to the attention of the physician by an actual pneumonia. In each case this occurred two to three months before admission to the hospital and gave a parallel history of failure to convalesce, as expected in an uncomplicated pneumonia. In each, secondary empyema was suspected by the attending physician and because of that was referred to the hospital for probable operation and treatment.

On physical examination the left chest in each instance was dull or flat over practically the entire extent. In the teratoma case, however, there is some evidence of diminished breathing posteriorly and a suggestion of diminished resonance over the base. Both chests showed definite deformities, and these deformities were among the more important differential diagnostic factors, as the deformity in each case was difficult to reconcile as due solely to fluid. Röntgenograms and fluoroscopic examination before aspiration showed a diffuse shadow in each case, with a few denser areas faintly out-

lined. After aspiration of the pleural fluid, the picture suggested an irregular shadow on the left side in each instance with several scattered deeper shadows of probable calcification. Even, however, by X-ray examination, the diagnosis of tumor could not be positive. The fluid removed by aspiration in both cases was very similar—a slightly blood-tinged amber fluid with a consistence of honey, almost mucoid, clinging to the sides of the tube—with a specific gravity of about .1010 and containing almost no albumin, albuminoses, or copper-reducing carbohydrates. Microscopically, neither con-
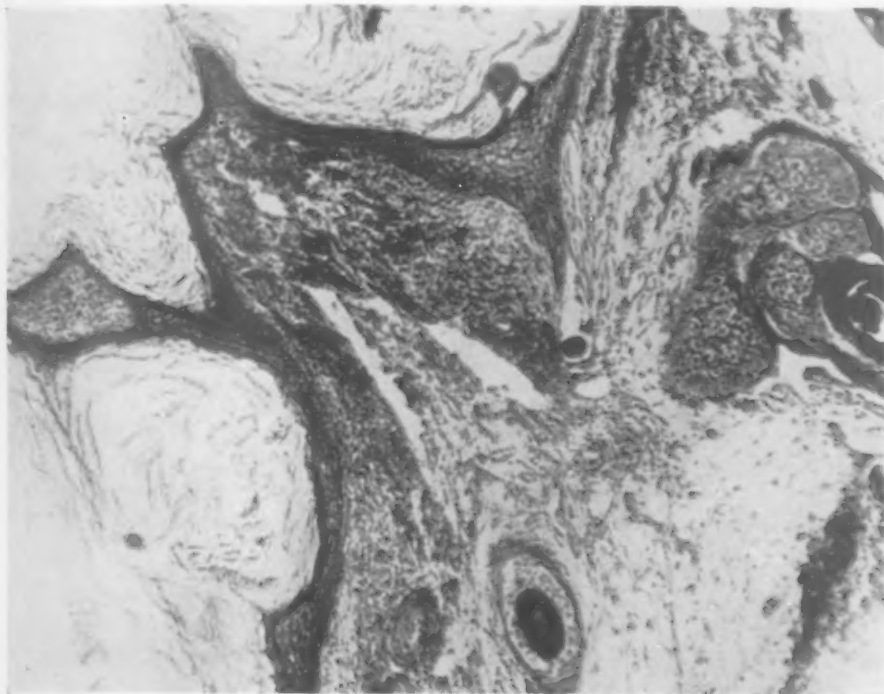

Fig. 7.—Case I. Low power photomicrograph of wall of typical epithelial lined cyst, showing cornification of epithelium, coil glands, hair follicle, etc.

tained many cells, about 10 per cubic millimetre as a maximum, and chiefly mononuclear in character. Each contained flecks of a sebaceous detritus. In the teratoma case a few hairs were noted in the last specimen examined, thus establishing the diagnosis.

The most important fact which these two cases bring out from the clinical side is the difficulty of differential diagnosis. They show the need of extremely careful history taking and physical examination. They emphasize the importance of the X-ray, and modern laboratory methods in diagnosis in such obscure conditions.

Pathological Discussion.—From the point of view of the pathologist, tumors of the mediastinum possess a peculiar fascination because of their comparative rarity and the wealth of speculative possibility which they stimulate. For that reason these two cases are of particular interest. The second

case we can dismiss with only a cursory consideration, as its etiology is so uncertain. From a careful study of both the gross material and the microscopic preparations, a pleural origin is very strongly suggested. In this opinion we are supported by several other pathologists who have seen the histological slides.

Adler,[1] in his discussion of malignant disease of the chest, offers a very complete bibliography. This particular case is younger than any of those mentioned in his monograph, but histologically seems to fall into the group of primary malignant tumors of the pleura. It is probably epithelial in origin rather than from any of the connective-tissue elements, which would classify it as a sarcoma. Our conception of carcinoma does not ordinarily include tumors in as young an individual as this baby. The usual clinical picture associated with true histologic carcinoma is that of a middle-aged individual, although there has been a small group of cases under twenty years of age among those reported.

In the case of the teratoma we have a more definite theory of etiology. Numerous hypotheses have been advanced, the more important being perhaps first, the conception that these tumors arise from ectodermal displacements, pulled down into the chest by the descent of the heart, or second, by some abnormal displacement of cells from one or other of the branchial clefts. This latter view unquestionably may account for certain of the tumors of the neck, particularly the epidermoid cysts, but does not seem to be a probable source of true mediastinal tumors. The conception of a blastomere which has become displaced in the course of development is perhaps the most tenable point of view to take. Upon the stage of development of this displaced cell depends the type of tumor which results, whether it shall be a simple cyst of the dermoid character, or a more complex tumor, such as the one described presents, or even a greater degree of complexity such as the one von Török[17] described, in which an abortive fœtus resulted. Wilms[18] concludes, from a study of many cases of dermoid cyst, that dermoids of the head, chest, and many of those in the retro-peritoneal tissue, are produced by abnormal development of germinal tissue, with the invagination of epithelium to form glands, or by a growth of fœtal fission cells. In the abdominal cavity particularly he feels that such teratomata should be regarded as a *fœtus in fœto*.

A search through the literature of mediastinal dermoids and teratomata reveals a total reported incidence of only 108 cases. Of these only eight have occurred in children under twelve years of age. Considering the general consensus of opinion in regard to the etiology of these tumors, as of fœtal inclusions or incomplete development of blastomeres, it is strange that the majority of these growths do not occur until adult life. And again, many of these tumors are not found until fairly late in life. The extremes reported are from one occurring in a suckling, about which very little definite information can be obtained, reported by Medoei[13] to one in a man of sixty-one, reported by Foa.[7] Numerous theories have been advanced to account for this discrepancy. Most noteworthy perhaps is the hypothesis that the body

economy is so actively engaged in promoting normal growth that these displaced cells remain dormant until physical development is complete. At that time the cells then become activated, possibly by some circulating material derived from the endocrine glands associated with the normal physiological changes of puberty, or by some infectious toxin. None of these theories adequately satisfy, but they serve at least as a possible explanation, and fall in line with the more generally accepted theories of neoplastic development.

The ordinary classification of these tumors of embryonal origin is into two
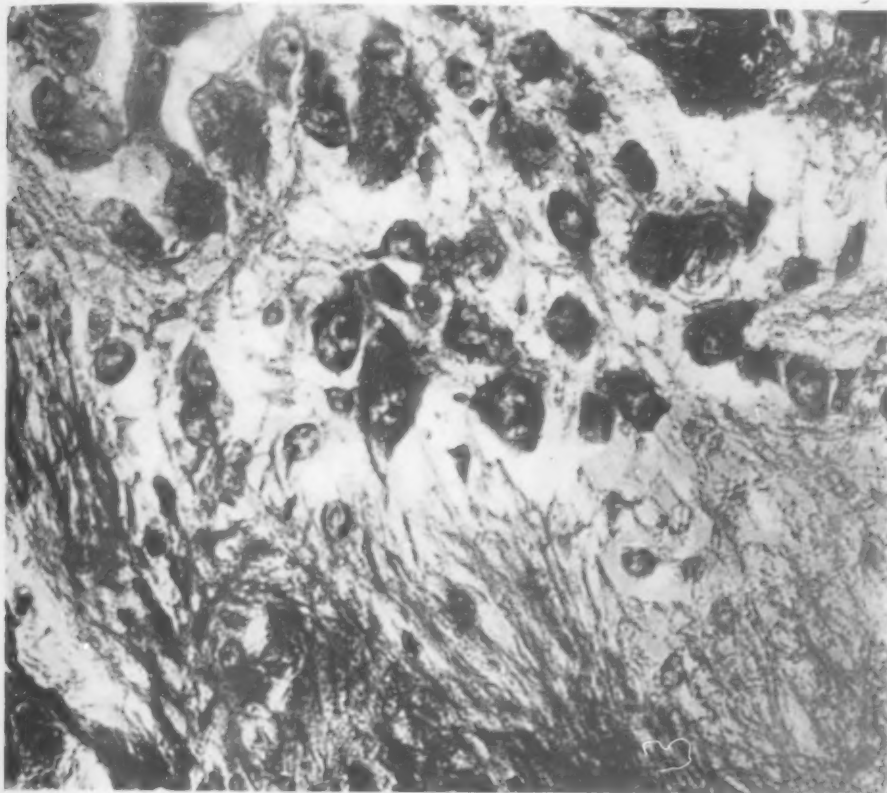
FIG. 8.—Case I. High power photomicrograph of characteristic ganglion cells and nerve fibres found scattered throughout tumor.

groups—one of the simple dermoid cyst, and the other the teratoma. This classification is based on a somewhat arbitrary division of the elementary tissues found histologically, and is the same as that employed in these tumors when found in the ovary. The dermoid cyst histologically consists of skin, including both the epidermis and its appendages, sebaceous and sweat glands, and hair, and the connective tissue of the corium with its derivatives, cartilage and bone. These may vary from a simple cyst lined by epithelium to more complex tumors, multilocular in character, in the walls of which may be found a supporting stroma in which cartilage and bone may play an important part, making a veritable frame-work for the various types of epithelium lining

the cysts which may differentiate into sweat glands, sebaceous glands, hair follicles or even teeth.

In the group classified as teratomata, the histological diagnosis is only made on finding derivatives of all three germ layers, ectoderm, entoderm and mesoderm. Thus, as in the case presented here, elements representing gastro-intestinal tissue or other organs derived from the entoderm, as well as nervous tissue, choroid retinal chromatophores and such ectodermal derivatives, are to be found in addition to the usual mesothelial connective-tissue stroma. This represents a cell inclusion of an earlier type, going back practically to the undifferentiated germ cell, while the simple dermoid represents a later stage in the germinal differentiation.

In a discussion of these mediastinal tumors it would not seem perhaps out of place to include in outline form the other cases which have been reported in children. These are, as previously noted, only eight in number.

The first of these was reported by von Török[17] in 1900. The patient was a girl of four and a half years of age, who was admitted to the Kinders-Hospital in Vienna with a pre-operative diagnosis of *caries costarum*. An operation was performed and a tumor mass found in the mediastinum extending into the left pleural cavity, attached to the pleura. It was the size of one's closed fist, and consisted of a cyst with a teratomatous protuberance filling nearly the entire cyst cavity. This was covered by what appeared to be normal skin. Mesially it presented a structure suggesting a head, with long tufts of hair and several teeth. In the anterior portion structures resembling intestine were noted. This intestinal tissue had a blind end directly in front of the vertebral column and was filled with mucoid fatty detritus. The tumor was about 12 cm. in its greatest length, and 8 cm. in its greatest breadth. The hair was fine, blond, and measured 20 mm. in length. An attempt to form an alveolar process was noted, with tissue resembling the epithelium of the lip and gums. Several molar teeth, with imperfect crowns, and one well-defined incisor were present in this alveolar process. Microscopically all types of tissue were found, including glial cells, epithelium of ciliated, cylindrical, cuboidal and squamous types.

The second case is that also noted above, reported by Medoei[13] in 1902. This report is incomplete. No note is made of the sex or exact age of the infant; nothing is known of the duration or of the size of the tumor. It was located in the anterior mediastinum and perforated a bronchus. Diagnosis was made by examination of the sputum in which hair was found. The tumor consisted of a cyst filled with fatty brei with a tuft of fine hair and considerable cholesterin. This case obviously falls into the less complex group of so-called "simple dermoid cysts."

The third case was reported by Dangschat[5] in 1903. The patient was a girl of twelve years, who was admitted to the hospital in June, 1899. A chest tap was done at that time and the fluid microscopically showed leucocytes and epithelial cells, chiefly of a squamous variety. Biopsy of the cyst wall microscopically presented a characteristic epidermoid-lined cyst whose epithelium was of the stratified type with definite cornification. No hair, teeth, bone or cartilage were found. A diagnosis of dermoid cyst was made. The patient was living at the time of report, four years later.

The fourth case, reported by von Eiselberg,[16] also in 1903, was a three-year-old child. No history concerning the duration of tumor was noted, and no comment upon the size of the tumor was made. It was located in the anterior mediastinum. It was described as a cystic teratoma with bone and cartilage formation, undergoing sarcomatous degeneration. These findings were made on post-mortem examination.

Madelung,[12] in 1904, reported two cases of dermoid of the mediastinum, one occurring

in a young adult twenty-seven years of age, and the other, with which we are concerned, was in a female child six years of age. This case was living three years after operation. The tumor was thought to have been present since birth. It was described as large and pedunculated, with four distinct parts described in great detail, both grossly and microscopically. It was located in the anterior mediastinum, behind the manubrium, at the level of the second rib. It was roughly conical in outline, covered by shiny white skin, with the previously noted pedunculated masses attached to the main body. The main tumor was covered with epidermis containing many fine hairs, some measuring as much as 22 mm. in length.

The epidermis presented numerous dimples. The other parts of the tumor were irregular in outline and had essentially the same structure. Microscopically the walls contained epithelium, chiefly of a squamous stratified character. There was some cartilage and bone in the underlying tissue, in which also were imbedded numerous sebaceous and sweat glands, and hair follicles. Thin bundles of smooth muscle fibres were present around the glandular tubes. Some of the tissue closely resembled lymphoid follicles. The tumor was classified as a dermoid cyst by the author.

The case reported by Jones[19] was in a male nine years old. Considerable doubt is present as to exact structure of this tumor. It occurred in the supra-sternal region and

FIG. 9.—Case II. Anterior view of thoracic and abdominal cavities with sternum reflected in left upper corner. This picture illustrates the approximate extension of the tumor to the abdomen.

was considered as possibly of thymic origin. It contained a fatty detritus which suggested a dermoid cyst. No histological examination was reported.

The case of Carpenter,[3] occurring in a female child of two, reported in 1906, also falls into the class of simple dermoid tumors. It was known to have existed for a period of about a year, and was the size of a closed fist. It occurred in the anterior mediastinum extending in front of the right lung and was attached to the pleura. It was multi-cystic, the cysts containing fatty detritus and fluid. The walls showed several excrescences, from which fine hair was seen to be growing. In the walls there was a good deal of calcareous deposit, but no actual bony formation.

The eighth case was reported by Prym[14] in 1914. It occurred in a girl eleven years of age, who was operated on for mediastinal tumor in 1912. The tumor was located in the right side of the chest, arising from the anterior mediastinum and extending from the seventh to the third ribs. It was adherent to the right pleural surface. Grossly, it was lobulated and the surfaces covered with epithelium. An excrescence about the size of a walnut was present, which was very solid on palpation, and from which grew a small tuft of hair. Suggestion of bone formation was noted, with imperfect development of an abortive alveolar process. Histological examination showed characteristic skin with hair, sebaceous and sweat glands. The subcutaneous fatty tissue contained
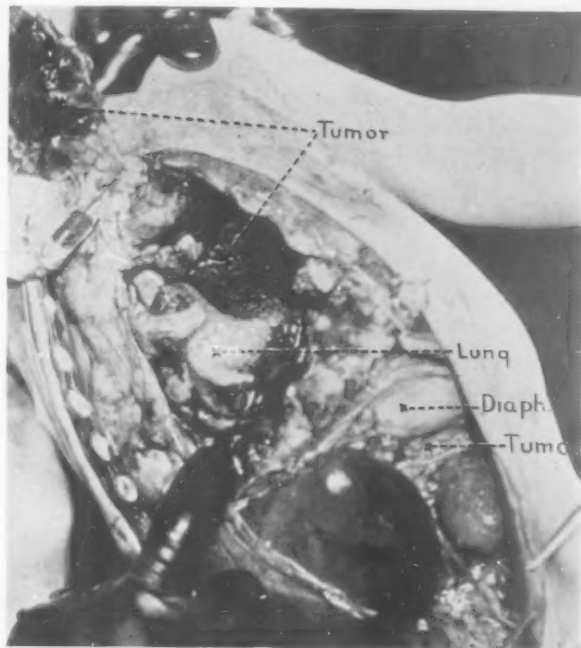
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some nervous tissue suggesting corpora amylacea or calcified blood-vessels. Tissue which represented a cerebral convolution, with the cells in places arranged like those of the cerebellum, also noted. Neuroglia tissue was present in generous amounts. Chromatophores, tissue suggesting choroid plexus, bone, fat, cartilage, muscle, lymph follicles and other miscellaneous structures were noted. The epithelial tissue ranged from stratified epithelium to high columnar cells, some of them representing mucous goblet cells.

In addition to these above reported cases there has come to our attention in the past few months another case of mediastinal dermoid of a boy of fourteen. This was diagnosed in the pathological laboratory of the Harvard Medical School by examination of the aspirated fluid from the chest, and was operated on with very satisfactory immediate results. The case is still under observation and sufficient time has not elapsed to warrant further discussion. We are indebted to Dr. J. Homer Wright † of the Massachusetts General Hospital for a post-operative description of the tumor.

An analysis of these eight cases and the one reported here is interesting. Six of the nine cases occurred in females, in two of them the sex was not noted in the reports, and only one definitely was found in a male. This is somewhat in contrast to the distribution between the sexes in the entire group of 108 cases, which have been reported, where the distribution is found to be nearly equally divided, forty-one being recorded in females, forty-three in males, and no sex noted in twenty-four. Again, of these nine cases occurring in children, five are simple dermoid cysts, while the other four show more complex structural characteristics which warrant their inclusion in the group of teratomata. One of these latter represents chiefly a dermoid cyst, but this showed malignant degeneration. It was classified by the author as a cystic teratoma with sarcomatous degeneration.

The age incidence is another feature of interest, five of these occurring in children under ten, thus even further restricting the group if we think in terms of decades. The age incidence of the total 108 cases falls into the following groups, arranged by decades: 0 to 10, 6; 11 to 20, 16; 21 to 30, 43; 31 to 40, 7; over 40, 10; not recorded, 26.

The clinical histories of these cases are in most instances very unsatisfactory. In only one of them is any definite knowledge of the duration recorded. In two of the others an approximate conclusion is drawn, without any very definite basis. The size of the tumors again is of some interest, ranging in those whose size is recorded, from a walnut to our case which measures 15 x 11 x 9 cm. The location varies somewhat, the tendency, strangely enough, being for these tumors to occur on the left side of the chest rather than the right, in spite of the resistance which one would think the heart would offer to growth in that direction. They all apparently originate in the anterior mediastinum, somewhere about the level of the second or third rib, and extend from that point upwards; in the case reported by Jones to a suprasternal position; laterally in five cases, four being to the left, and one to the right. In three it is not recorded, and in one it remains localized to the anterior mediastinum.

† Personal communication.

The gross appearance again varies so much as to be scarcely worth while elaborating. Roughly, they are ovoid or spherical in outline, tend to be lobulated, usually adherent to the pericardium and pleura, are always cystic, occasionally unilocular; in the more complex ones multi-lobular. Their diagnosis is usually confirmed by finding hair or sabaceous material by aspiration or in the sputum. These are perhaps the more important features noted in these mediastinal tumors.

The literature has been variously reviewed at irregular intervals by workers who have been stimulated by finding such a case. Christian,[4] in 1907, reported in the *Journal of Medical Research,* an analysis of the forty cases which he could find up to that time. No further complete review of the literature was made until 1916 when Hertzler,[9] in the *American Journal of Medical Sciences,* reported a case and summarized the literature up to that time. Again, in 1919, Harris,[8] in the *Ohio State Medical Journal,* supplemented Hertzler's bibliography by numerous other foreign reports which had not been previously included, and likewise included the cases occurring from the time of Hertzler's publication.

FIG. 10.—Case II. High and low power photomicrographs of tumor illustrating the typical papillary arrangement of the tumor cells.

Since the original writing of this report in 1922, Murphy[19] has presented a paper in which several cases not previously recorded are found. Only one of these strictly falls into the age group which we have discussed, but his own and one other are both in children under fifteen and are for that reason mentioned for the sake of completeness.

Murphy's case unfortunately could not be confirmed histologically, as she died before being operated upon and post-mortem was refused. The case was in a girl of thirteen and the course was rapid, covering a period of
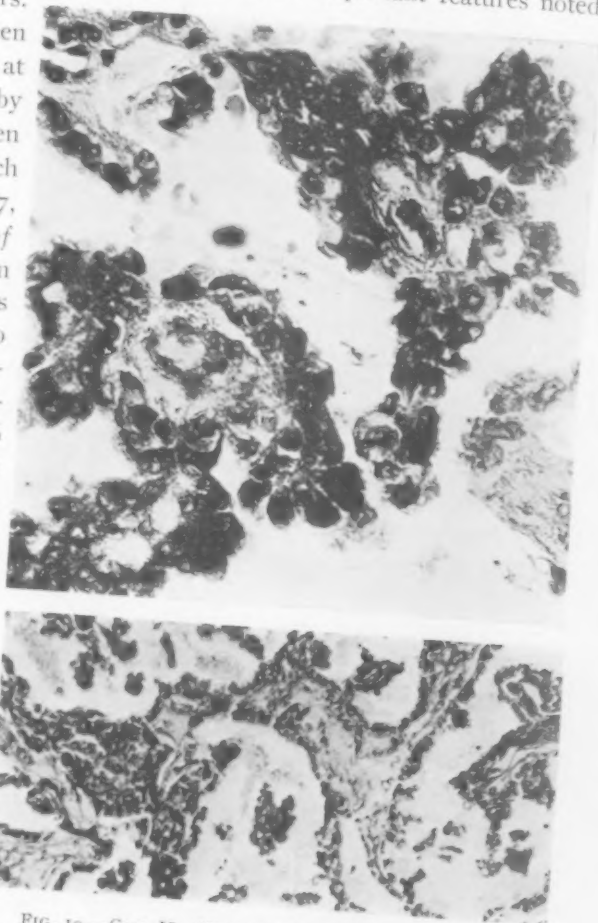
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six weeks, strongly suggesting the possibility of a thymic or lymphatic tumor. She was treated by X-ray, without benefit.

Kahn [20] reports a case in a girl of fourteen, and Pohl,[21] in 1914, gives the details of a similar solid teratoma in a girl of ten. His case came to autopsy and was proven histologically. At that time he commented on finding only two other similar cases in the literature up to that time. One of these was in a boy of fifteen reported by Virchow,[22] the other in an older patient.

Whittemore,[23] in 1923, gives the history of the case referred to from the Massachusetts General Hospital.

Several other cases in adults have been reported. No attempt is made to cite all of these in the appended bibliography, as this paper is intended only to record those cases occurring in children. In this respect every effort has been made to make it as complete as possible, verifying the cases by referring to the original papers for the most part. Unquestionably, omissions will be found, for as the data accumulates, cases under obscure titles will be brought to light. Already the total of the reported cases approaches 125, and we can see that the condition is not so rare as it was thought to be, even ten years ago.

Conclusions.—Two cases of mediastinal tumors in children are reported. The difficulty of differential diagnosis is emphasized, requiring the use of modern laboratory methods. The only treatment of these tumors is surgical, if they present symptoms due to pressure.

A review of the other mediastinal dermoid cysts and solid teratomata in children is presented and a discussion of their etiology is given.

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THE TREATMENT OF SUPPURATIVE PERITONITIS*

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The selection of this subject is not altogether my own. I have been told, however, that there are still different views in regard to the treatment of peritonitis and that it would be interesting to compare my present views with those I expressed some twenty years ago.

In 1903, I read a paper on this subject before the American Surgical Association † and in another paper, read a year later,‡ reported additional experience with the treatment I had advocated. In these papers a definite distinction was made between cases of diffuse peritonitis and localized peritonitis. The term diffuse peritonitis embraced the cases of so-called spreading peritonitis, in which there is no limitation of the process by adhesions or gravitation but in which the limits are ascertainable, and cases of generalized peritonitis in which no part of the peritoneum excepting the lesser sac can be demonstrated as free from invasion. The term local or localized peritonitis was applied to cases with abscess, in which there is a localized collection of pus with limiting adhesions.

Too much emphasis cannot be laid upon the differences in the treatment of these two groups. A local peritonitis is essentially an abscess, a walled-off process, and should be treated by evacuation and efficient drainage. Being localized, removal or suppression of its cause is not always absolutely necessary. In fact, as we know, it may add unjustifiable danger to the operation.

On the other hand, diffuse peritonitis is an unlimited process in that its cause is still operating to promote its progression in both degree and extent, and therefore its cause should be suppressed or removed. In diffuse peritonitis the intensity of the process, except in the immediate vicinity of the cause, has rarely gone on to the point of necrosis and pullulation of bacteria in the tissues of the peritoneum, because the patients succumb before such a degree of infection becomes extensive. In other words, the large surfaces exposed to perhaps even a purulent exudate, even though irritated and congested, are contaminated rather than infected.

Rational methods of treatment must be based, with due consideration, upon these differences between localized and diffuse peritonitis. Twenty years ago almost universally, cases of diffuse peritonitis were treated like cases of local peritonitis and as many drains were introduced as there were fossæ or pockets in the peritoneal cavity. Sometimes glass, sometimes rubber tubes,

but not unfrequently gauze packings were considered proper appliances for drainage. The rôle drains played in producing traumatism and establishing infection was not appreciated. Evisceration and cleansing the cavity with sponges was frequently practised. The mortality was distressing.

About this time Ochsner described his method of procrastination in the treatment of peritonitis which was based upon the principle that physiological rest of the alimentary tract tends toward localization and even resolution of diffuse peritonitis. It was a great contribution to our knowledge of the pathology and treatment of peritonitis; but I have always believed it should not be employed when the cause of peritonitis could be removed. For, as has already been mentioned, the infected organ from which the infection extends in a case of diffuse peritonitis continues as a source of infection, and areas which at first are simply contaminated finally become infected. Furthermore, in those early days, operations for localized peritonitis, that is abscesses, were attended by far less mortality than were those for diffuse peritonitis, so that it seemed desirable to wait for localization. With our present methods, I believe the converse is true and that the prognosis of operations for local abscesses, at least those of appendical origin, is more grave than that of operations for the average cases of diffuse peritonitis of similar origin.

The dangers of prolonged suppuration in the peritoneal cavity may be divided into two categories; firstly, those arising from extension of infection such as portal phlebitis, subphrenic and other secondary abscesses, perforations and infection of other organs and all the other sequences of chronic sepsis; secondly, those caused by repair or by operation, such as adhesions, intestinal obstruction and post-operative ventral hernia. These dangers are as a rule avoided if an early operation is done and the origin of the infection suppressed.

My contention as expressed in 1903, in regard to the usual cases of diffuse peritonitis in which the cause could be suppressed, was that given a short anæsthesia and a quick operation the danger of interference was much less than that of procrastination; and I do not believe any reason has developed since for changing that view, with the exception of some cases of gonococcus and pneumococcus peritonitis which I shall consider later.

One of the advantages of an early operation is the avoidance of the necessity for drainage. Of the 32 cases of diffuse peritonitis reported by me in 1903 a comparison showed that the duration of convalescence in the undrained was about three-fifths of that of the drained. My practice was to use drains only when the presence of necrosis or hemorrhage demanded it. A rule I had was that, after removing the cause and cleansing the peritoneum, drainage should not be employed unless there were areas of necrotic fibrin such as form the walls of an abscess, or bleeding which could not be controlled except by packing. In other words, if all of the peritoneal surface was practically alike, drains should not be used. If in strong doubt, drains were to be used. When I speak of drainage I mean drainage of the peritoneal

cavity or parts of it. In all my cases the wounds in the parietes were drained, the drains passing just into the peritoneal cavity. This method has since proved to be correct in the treatment of suppuration of the joint and pleural cavities.

Abscess cavities, areas in which on account of necrotic fibrin or tissue continued suppuration cannot but take place, and leaking organs should be efficiently drained preferably by a doubled rubber tube, so that the necrotic material may be washed out as soon as it separates.

Cleansing the peritoneum is important if it can be carried out without causing injury or unduly prolonging the operation. One would not tolerate leaving gastric contents, food, or fæces in the cavity, nor should one leave quantities of blood or pus. In 1903, I advocated peritoneal lavage, using large quantities of saline introduced with a tube or poured from a pitcher and mopped out with gauze. By 1904, I used a two-way irrigator, the excess fluid being removed by siphonage. This was a great improvement over the former method, as practically no traumatism was inflicted. The present mechanical suction apparatus with which nearly every hospital is equipped, affords a still more rapid and efficient means of cleansing, for the saline only has to be poured in from a pitcher and almost as rapidly removed.

At present I do not attempt to be as thorough in washing out the cavity as I formerly was. I usually am content with rinsing the immediate vicinity of the site of operation unless I have reason to believe foreign materials or pus have been spread further. However, considering our present conception of contamination and infection, it would appear reasonable to remove contamination to the extent of our ability.

In some cases, such as almost moribund cases of appendicitis in which prolongation of the operation by every moment counts, all considerations as to ventral hernia or shortening convalescence must be disregarded and only so much done as is likely to turn the tide of infection—simply a drain to the appendix, or if it is readily accessible its removal and a drain may be sufficient. Local drainage only should be employed. Multiple drainage incisions are absolutely contra-indicated. The chances for recovery are better if the outlying regions of the peritoneum are untouched. Resolution throughout is more apt to result, and even if local abscesses form, they are more safely dealt with as they become evident. The cases of so-called fibrino-purulent peritonitis are cases in point. It is foolhardy to break down the adhesions and either wash out or drain all the pockets. The mortality although great, is less if the cause alone is removed and the outlying pockets left to resolve or form abscesses to be opened later.

Ileus is one of the most distressing and dangerous complications of peritonitis. Usually of the paralytic type alone, it may become virtually obstructive, more frequently of the angulation type, because of kinking at adhesions of the distended loops. The other types, except possibly that

caused by drainage tubes (compression ileus), do not particularly interest us in the treatment of peritonitis itself. Many deaths attributed to the septic intoxication alone of peritonitis are immediately caused by ileus and its depressing action upon the vitality and resistance of the patient. It becomes the determining factor in the vicious circle of sepsis, meteorism, stasis, putrefaction of intestinal contents, septic intoxication. If not present before operation it should rarely occur after, for it is usually caused by unnecessary roughness and thoroughness in operating. When present before operation, it is more than likely increased by the operation and demands serious consideration. Formerly, I was satisfied with opening the small intestine, emptying the adjacent coils through the incision and then closing. I have come to the conclusion that this was bad surgery, because ineffectual and necessitating too much handling of the intestines. I now introduce a 20 F. to 24 F. catheter as near as possible, by guessing, into the middle of the ileum or distended coils of small intestine. The wall of the intestine is inverted by a couple of purse-strings and no attempt to empty the gut is made at the operation. This drainage of the intestinal canal has saved almost more lives, I believe, than have the drains put into the peritoneal cavity. At least, it has not killed so many. My custom has been to leave the catheter open, it draining continuously into a bottle by means of a connecting tube and extension, and to irrigate the intestine every two or three hours with water, always leaving a few ounces remaining in the gut.

My routine treatment otherwise is the ordinary post-operative treatment following abdominal operations; namely, an ampoule of surgical pituitrin every four hours for six doses, gastric lavage and colonic irrigations when indicated. In case of colonic irrigations they should be timed to be begun fifteen minutes after a hypodermic of pituitrin; in case of an enema, one-half hour after. If irrigations or enemata are indicated after the initial six doses of pituitrin, an additional ampoule of pituitrin is given before each.

Reference has been made to gonococcus and pneumococcus peritonitis, as presenting peculiarities which require treatment differing from the ordinary types of suppurative peritonitis. In both of these infections the organisms are not so virulent or so dangerous as are the pyogenic bacteria. The chances of resolution and localization are accordingly greater and the need for early operation less. The difficulty is in making a diagnosis. If it can be made and one is sure he is dealing with one of these forms, delay in operating is frequently advisable.

Pneumoccic peritonitis may be idiopathic, at least no atrium of infection can be demonstrated and, therefore, there is no advantage in, but on the other hand, distinct contra-indications to operation before localization has taken place and an abscess can be opened. In cases of appendical origin which, in fact, are generally mixed infections, of course operation to remove the cause is indicated.

In cases of tubal origin just as in cases of gonococcic peritonitis, if operated on during the acute diffuse stage, I have found the mortality very high, unless the tubes were removed. When the tubes were not removed, drainage was employed. When the tubes were removed the abdomen was closed without drainage. Most of the former died and all of the latter recovered. The outcome of these cases again justifies the opinion that in diffuse, spreading peritonitis, operation is not beneficial unless the atrium of infection can be suppressed, and also that drainage tends to continue and accentuate infection.

In conclusion, I wish to emphasize the importance of making accurate diagnoses so that operation when indicated, can be planned so as to eliminate the cause with the least loss of time and the least traumatism.

I shall also add that no absolute rules or maxims can be laid down. The best results will be obtained by those who combine judgment and knowledge of the reaction of tissues and organs to infection and injury with diagnostic acumen and technical skill; which are in fact the attributes every surgeon should possess.

THE VALUE OF THE RÖNTGEN EXAMINATION IN THE EARLY DIAGNOSIS OF POST-OPERATIVE ILEUS *

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There are few incidents in the post-operative course of a surgical case more distressing than the calamity of acute intestinal obstruction. As one writer has put it, after a patient has undergone the mental and physical strain attendant upon a severe surgical operation, and has just begun to feel the satisfaction and physical benefit consequent upon h a v i n g passed safely through such an ordeal, to be called upon again to submit to further greater s u r g i c a l hazard is to stretch a l m o s t to the breaking point the fortitude and the physical endurance of the hardiest. It is true this experience comes to the surgeon with much less frequency now than formerly, thanks to numerous improvements in the technic of preparatory and surgical treatm e n t. Particularly has this been true in our own surgical work since the abandonment of the practice of pre-operative catharsis. As one familiar with the striking differ-

FIG. 1.—Very marked distention of the colon with gas in a case thought to be acute small intestinal obstruction. The gas distention was relieved by washing out the colon and the administration of pituitary extract. The distribution of the gas and the characteristic markings of the bowel outlines indicate colon rather than small bowel.

ence in the peristaltic behavior and gas-content of the gastro-intestinal tract as seen with the X-rays in cases with and in cases without purging, the writer early adopted the plan of giving no preliminary preparation of the bowels

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* Read before the Western Surgical Society, December, 1923.

other than by cleansing enemas, except in a very few cases where the history of the nature of the lesion seemed to call for a different program of preparation for surgery.

The most experienced surgeon at times feels much uncertainty as to the nature of an acute abdominal lesion when characterized by apparent obstruction of the bowel; and yet the patient's chance of recovery depends most of all upon the early recognition of the fact of obstruction, should it prove to be a case of ileus. If one delays long enough, following an abdominal operation, the occurrence of inhibited bowel activity, accompanied by progressive abdominal distention, beginning within twenty-four hours, unrelieved by ordinary remedies, continuing in a most obstinate and progressive manner during the second, third and fourth days, with rapid pulse, increase in temperature and rate of respiration, restlessness, cold perspiration, vomiting of dark material, sometimes with fetid odor, but without the passage of gas or fecal matter from the bowel, with finally tense distention of the abdomen, leaves no doubt as to the existence of an acute post-operative ileus! Even the passage of gas and fairly satisfactory bowel movements does not exclude an obstruction which may have occurred high up in the small gut. This obstruction may be a paretic condition, due, for instance, to infection, or it may result from mechanical conditions.
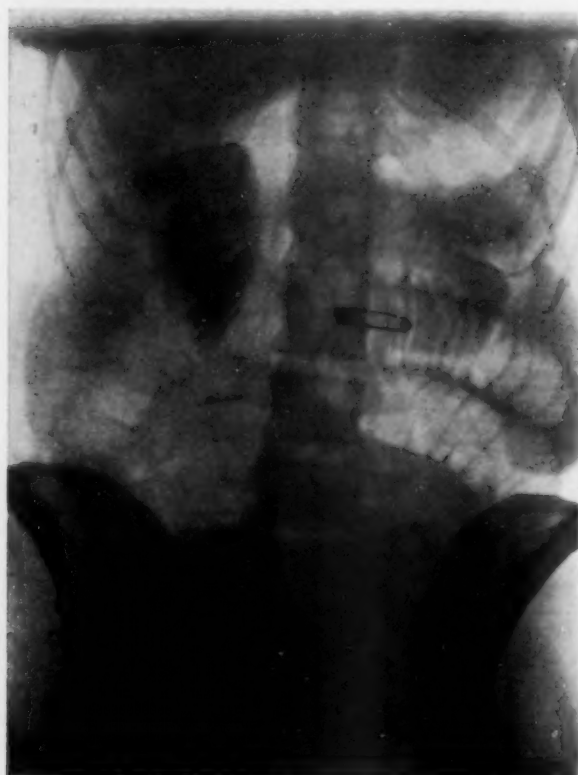

Fig. 2.—Acute obstruction high up in the small intestine, somewhere near the junction of the jejunum and the ileum. Note the absence of gas-distended coils in the lower half of the abdominal shadow.

In the treatment of post-operative ileus early recognition of the condition is of the greatest importance in order that the profound general depression attending the later stages of obstruction may be minimized or averted. The effect of the time element in these cases is graphically shown in all statistics, by the steady increase in the mortality rate which accompanies the lengthened interval allowed to pass between the occurrence of the obstruction and opera-

FIG. 3.—Marked gastric dilatation. Acute obstruction low in the small bowel, yet a little distance above the ileocolic junction. One determines this by the distribution of the gas-distended coils. The trace of barium in the cæcum remained there from a pre-operative barium meal study.

FIG. 4.—Very high grade of acute obstruction near the ileo-colic junction. The dilatation of the entire small bowel in this case was extreme.

Fig. 5.—Acute obstruction in the small intestine in which the decision to operate was not made until the second examination, six hours after the first. Meanwhile a small amount of barium had been given and the characteristic appearance of the small bowel visualized.

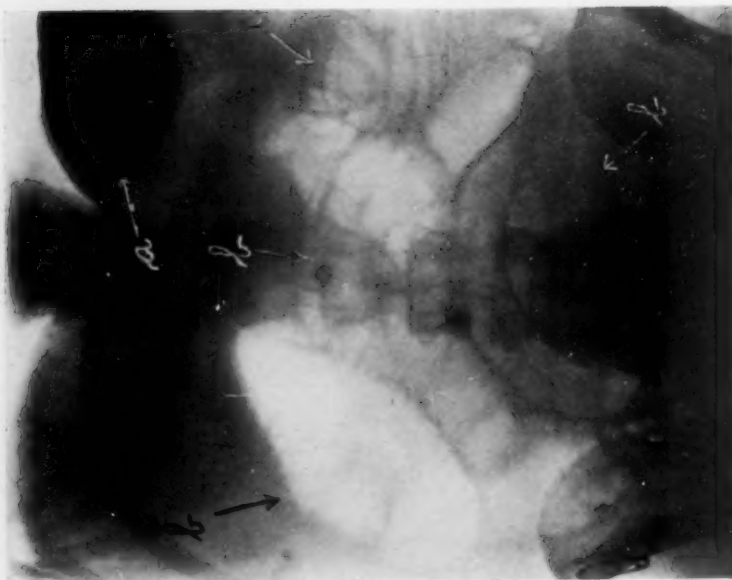Fig. 6.—Acute post-operative ileus, plate made immediately after the administration of one ounce of barium stirred in water. (a) Stomach. (b) Numerous coils of gas distended intestine, characteristic of acute intestinal obstruction. Nevertheless operation not yet decided upon. See Fig. 7. Gas distended ileum differentiated from colon (c) by feathery outline. Colon characterized by haustral markings.
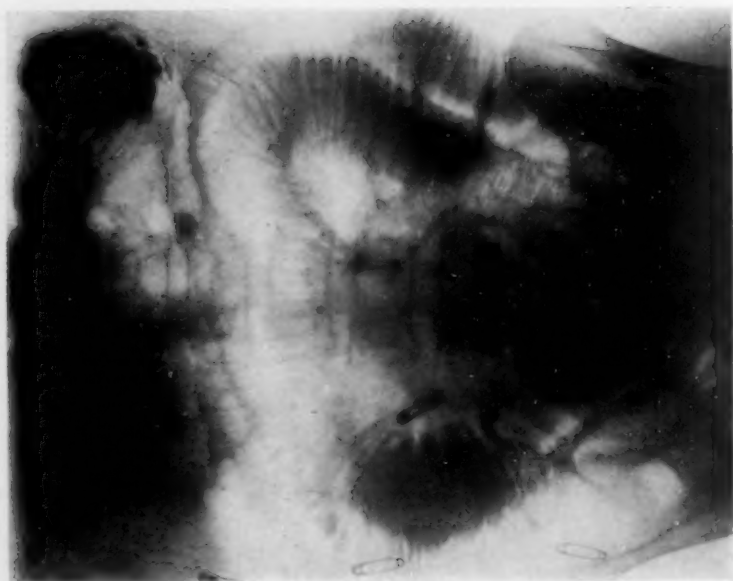
tive intervention. It is the purpose of this paper to describe a simple, quick method, which is nowadays universally available, for shortening the time of observation before reaching a decision to intervene.

Naturally every surgeon regards with suspicion any untoward post-operative symptoms, one or more of which occurs to some degree in the majority of abdominal cases. A complaint of fullness, particularly in the epigastric region, accompanied by vomiting or frequent gagging or gulping of small quantities of dark fluid, or any one of a number of other symptoms belonging to the category of symptoms of possible ileus, becomes at once a cause of disquietude. If twenty-four hours can be saved in reaching a decision in a case requiring further operation, great help has been rendered. The method hereinafter described can render such help.

While recognizing the comparative certainty with which intestinal obstruction can be diagnosticated from the clinical and physical examination, the necessity for making the earliest possible decision to operate or not to operate, impels the writer to venture to again call attention to his experience in the employment of the X-ray examination as a

FIG. 7.—Same case as shown in Fig. 6, six hours later. (a) Distended coil of jejunum more clearly shown up by barium. Enterostomy. Cure.

diagnostic adjunct in these cases. In 1910, he began the use of the X-ray study with the present technic in cases of suspected ileus, especially when surgical interference was not clearly indicated. These observations were reported in 1914, before the American Röntgen Ray Society and in 1915 at the San Francisco meeting of the American Medical Association. The simplicity and safety of the procedure has been freely admitted by a number of prominent surgeons, but rather extensive visitation among the leading hospitals of this country gives the impression that the surgeons for the greater part continue operating late, though without exception deprecating such late operation and advocating early intervention. It requires no small degree
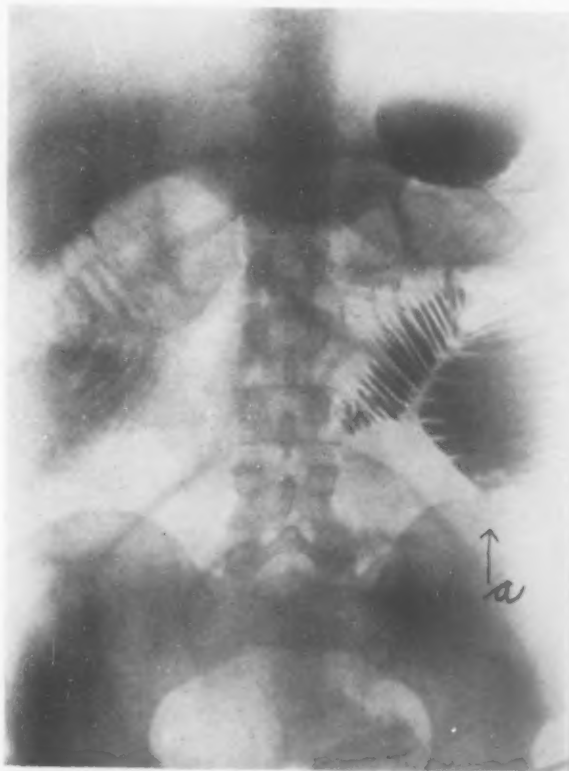
of courage to face the patient and the friends and go in again after the abdomen has once been closed.

It is not claimed that the X-ray test here described will differentiate with surety between the paralytic and the mechanical forms of ileus, nor that the exact site of the obstruction will be made clear, but the one essential fact which can be determined with reasonable assurance is the presence or absence of obstruction. Does it exist or does it not?

This method of study is gaining ground in European surgical clinics. Gosset of Paris is using it. Guillaume (Bull. et mém. Soc. anat. de Par., vol. xviii, p. 511, Dec., 1921) notes that röntgenographic study of the gastro-intestinal tract is rarely carried out in such cases, perhaps for fear of producing serious reactions by the administration of opaque test-meals. However, the ingestion of barium-mixed broth is not necessary to the examination. The films made with the patient in the supine position, without an opaque meal, reveal the contours of the intestine plainly enough to establish the diagnosis. One of the German clinics has now studied more than a hundred cases in this manner.

FIG. 8.—Acute small intestine obstruction, upper abdomen, attending gangrene of cæcum in case of carcinoma of sigmoid; showing gas distended stomach and three parallel reaches of enormously distended small bowel crossing upper abdomen. Death, in spite of operation.

The technic which we first described in 1914, with slight modifications made possible by improvements in X-ray apparatus, is as follows: Counting the day of operation as the first day, given a patient on the third day after operation presenting symptoms suggestive of acute intestinal obstruction, the portable Röntgen apparatus now available in most approved hospitals is wheeled into the patient's room, a fourteen by seventeen inch film with screen, in the proper film-holder, is slipped beneath the patient's abdomen, the interiliac line being slightly below the middle of the film. No dressings are removed, and, if the patient's condition requires it, even the bedclothing may be replaced once the X-ray tube is centred over the middle

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FIG. 9.—The fact of intestinal obstruction is definitely shown in this case without any barium. Yet, because of the indecision regarding the need of operation, barium was administered and another examination made twelve hours later. See Fig. 10.

FIG. 10.—Same case as Fig. 9, except that the barium now visualizes the distended small intestines. The operation which was then done had been unnecessarily delayed twelve hours.

of the abdomen. The patient is asked to hold the breath for a few seconds, the exposure of two to four seconds is made, the film removed and the apparatus taken from the room at once. The whole procedure need not require more than five minutes. The film is at once developed, and it may be studied immediately after being dipped in the fixing solution. Thus the surgeon may within fifteen minutes from the time he desires it study a röntgenogram of the patient's abdomen, without any more disturbance to the patient than that incident to a slight change of position in bed. No preparation of any kind is required.

The developed film will reveal at once whether there is any gas distention of the bowel or stomach, and if so, whether the distention o c c u r s in the stomach, or in the large or small intestine. Enormous gas stretching of the stomach is occasionally seen, and the absence of such a gastric gas accumulation at once rules out post-operative dilatation of the stomach. Small and large bowel may be distinguished by the characteristic outlines of the gas areas. The haustral markings as well as the peripheral distribution of the gas along the course of the colon rather than
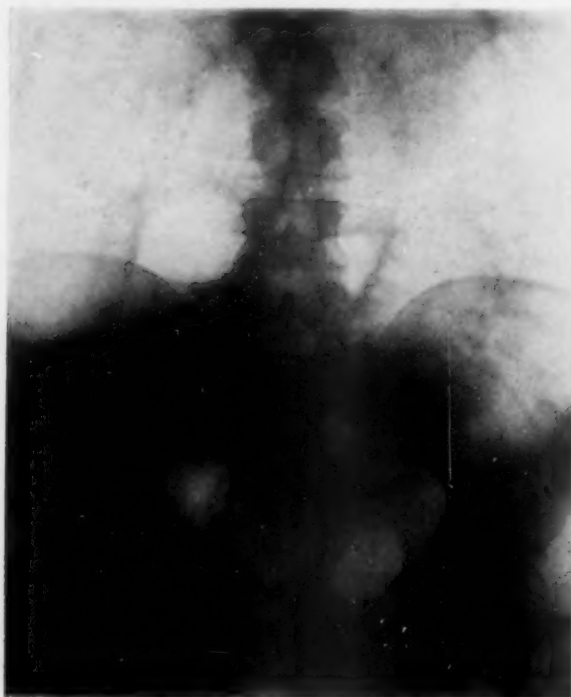

FIG. 11.—A case in which the gas distention was shown by the röntgenogram to involve both small and large intestine. Under non-surgical treatment the gas distention was relieved. See Fig. 12.

in the middle of the abdomen, are sufficiently characteristic to identify the large bowel. Equally characteristic is the appearance of the gas-distended coils in acute obstruction of the jejunum or ileum; the coils are more or less parallel and the caliber of the small gut is increased to one and a half or two or even three inches as measured on the X-ray film; and when it is recognized that this film is a life-sized record of the actual measurements, with only slight distortion, it is easily seen that such increased diameters of the bowel shadows mean actual distention to the degree indicated. It is seen that the distention is not confined to a short segment of the intestine but involves one or more feet, usually several loops. Of course, a certain amount of post-operative distention of the small intestine is frequently noted where there are no symptoms suggestive of obstruction, but in the serious

cases the degree of distention is at once apparent and suggestive. Paralytic ileus in some degree probably exists in a much larger proportion of abdominal cases than is usually believed to be the case, relief being obtained during the post-operative routine management of the case without being definitely recognized.

The serrated contour of the small intestine is characteristically different from that of the colon due to the markings of the haustra coli; so that we should be able to recognize at once and differentiate acute post-operative gastric dilatation and obstruction in the small or in the large intestine.

Observation of the cæcal region is especially helpful, for if the cæcum contains gas, it is not likely that the obstruction is in the small bowel. The case illustrated in Fig. 11 is very instructive on this point. Most of the gas is contained in the cæcum, yet the coils of distended small intestine occupying the left side of the abdomen are clearly seen. Redoubled efforts to get the bowels to move were successful in this case, and the patient made an uneventful recovery without further operative interference. If there had not been present the marked distention of the cæcum, operation would have been urged. If the gas collec-

FIG. 12.—Same case as Fig. 11, on day of discharge. This cut illustrates the appearance of the normal abdomen when the röntgenogram is made under the conditions described in this article.

tions, as above described, are seen to occupy the middle of the abdominal shadow while the flanks are gas-free, it is probable that the obstruction is in the lower ileum though not so low as the ileocæcal valve. When the gas areas occupy the true pelvis and the middle of the abdominal shadow, one may suspect the ileocæcal region. Intussusception may be recognized by colonic injection with an opaque enema. In doubtful cases, the opaque enema may add to the information to be obtained from the X-ray study, without embarrassment to the patient.

If the observation of the gas-filled bowel (without the ingestion of barium) does not make clear the approximate location of the obstruction, time will be saved by proceeding at once with the barium enema to rule out colonic obstruction. If the entire colon fills, it is then recognized that the obstruction must exist in the small bowel. If the findings up to the moment are still indecisive and doubt as to the need of operation still exists, a small amount of barium sulphate, say half an ounce, may be administered by mouth in any medium which the patient will swallow. These cases are often so doubtful from the clinical standpoint that final decision as to operation is postponed for a few hours in any case, and there is thus ample time for some of the barium to pass on into the small intestine. After a little experience, however, it is quite unnecessary to administer any barium at all by mouth, the decision being rendered on the appearance of the abdominal shadow with reference to the character and distribution of the gas areas which may be present. If non-surgical treatment still seems indicated, the progress of the case under treatment may be watched by occasional films made to determine the progress of the small amount of barium which was administered, or which may now be administered without fear. Nevertheless, emphasis is laid on the fact that it is not necessary to administer barium or any other opaque material in pursuing these studies, for in the great majority of cases even the subsequent observations may be made on the gas appearances. There is therefore no delay incurred, and no objection can be raised to the X-ray study of these patients on account of possible danger through delay or through the introduction of new food or foreign material into the digestive tract in the presence of possible obstruction.

It must be admitted that the employment of the above technic without the use of barium sulphate does not routinely give satisfactory data unless the case

FIG. 13.—Case of ileus associated with peritonitis. By experience one comes to recognize that this type of hindrance is characterized by gas distention, both in the colon and in the small intestine, and in spite of it partial success attends efforts to empty the bowel.

is immediately post-operative. This is possibly due to the fact that in nearly all post-operative cases, the bowel is practically empty, whereas in the other classes of acute intestinal obstruction, the intestine is often loaded with food residues. Nevertheless, when used in conjunction with an opaque meal or enema or both in appropriate cases, the X-ray method gives decisive information in any class of intestinal stoppage.

The writer wishes to again emphasize the statement previously made in this article that the suggestion of this X-ray method for establishing a diagnosis of ileus is not intended to in any way serve as a substitute for the other clinical methods already in general use, but this X-ray examination, carrying with it so little disturbance to the patient, requiring no preparation, and often giving such important help, is suggested as just one more means of diagnosis in the hope of reaching more quickly a definite decision. Needless to say this report is based upon a very extensive post-operative X-ray study covering several hundred patients, the great majority of whom had no untoward symptoms during their post-operative course, the examination being made to establish the normal post-operative behavior of the bowel and to serve as a basis for the conclusions above expressed concerning the value of the X-ray study in the early diagnosis of post-operative ileus.

SOME SURGICAL RELATIONS OF CHOLECYSTITIS *

By John B. Deaver, M.D.

of Philadelphia, Pa.

The function of the gall-bladder is still a matter of controversy; however evidence goes to show that individuals get along quite well without it so that we do not as yet definitely know how essential a part of the human body it is. But I often wonder whether one of the functions of this interesting organ is not that of forming a fruitful source of discussion among the profession. The inordinate amount that is being written and spoken about disease of the gall-bladder and the extensive investigations concerning its pathology, bid fair to exceed those which hitherto attached to the appendix and to peptic ulcer. In this widespread discussion it is well to remember that disease of one organ rarely fails to affect neighboring organs, thus illustrating the old adage that evil associations corrupt good manners.

This applies with exceptional force to the upper right abdominal quadrant. Here within an area easily covered by the palm of a man's hand we find the antrum of the stomach, the duodenum, the gall-bladder and bile passages, the head of the pancreas, the right kidney, the ascending portion and hepatic flexure of the colon, and finally a little further down the ubiquitous appendix. If, in addition to this anatomic relationship, we consider the more or less common nerve supply to these organs and the more or less free lymphatic communication between them, we have an explanation for the striking tendency to associated disease in this interesting quadrant of the abdomen.

As in nearly all non-neoplastic diseases of the upper right abdomen, the fundamental cause of disease of the gall-bladder is infection, and whether this takes place by an ascending or a descending route or a hæmatogenous or a lymphogenous route, it is the cause of the inflammation which leads to disease of the gall-bladder. The rôle the liver plays as the original distributor of this infection is a paramount one in present-day discussions of this subject. Bacteria are doubtless carried to the liver through the portal circulation, in the same manner as bacteria are continually passing through the kidney, and failing to be completely destroyed by the action of the liver are secreted in attenuated form, probably in the bile, as it enters the gall-bladder. And if Sweet's recently expounded theory that what enters the gall-bladder does not come out is correct, we have an easy explanation of some infections of the gall-bladder and the biliary tract.

But leaving aside this attractive theory, from a practical viewpoint we are aware of one or two important facts, namely, that owing to the interrelationship of the entire biliary system it is not difficult to suppose that infection within its confines necessarily affects its component parts, and secondly, that

in view of this we must expect more or less wide variations in the clinical picture of cholecystitis. The picture is of course influenced by the extent of the lesions and the presence or absence of stone formation. Clinically, nearly every cholecystitis is a cholelithiasis. In the Lankenau Clinic we find that only about 18 per cent. of the cases of cholecystitis are not associated with gall-stones. The clinical differentiation between a calculous and non-calculous cholecystitis is not always possible, for at least 70 per cent. of the latter give a history of attacks of pain resembling gall-stone colic and about 35 per cent. a history of jaundice. X-ray diagnosis is not always reliable in view of the fact that not every type of gall-stone is demonstrable by X-ray, although it may confirm the clinical suspicion of the presence of gall-bladder pathology. Another circumstance that must be borne in mind is that it is not the presence of the stones so much as the complications and pathology they may cause that demands the surgical treatment of cholecystitis. The theory of innocent gall-stones has long ago been proven a myth by W. J. Mayo and others. A careful history of the cases which claim never to have had any symptoms of gall-bladder trouble will usually reveal some indication of the disorder at a more or less remote period before coming to operation.

Clinically also, nearly every cholecystitis is associated with hepatitis and oftentimes with pancreatitis, although the degree of involvement may be so slight as not to be diagnosable, clinically. Pathologically, however, the liver, as I have frequently observed, so often does show such pronounced evidence of disease that one naturally is led to believe that a primary infection of this organ has extended to the gall-bladder, and in turn from the gall-bladder to the pancreas. That infected bile is the germ carrier and the lymphatic, the route it pursues is now being more generally recognized than formerly. Personally, I have adhered to this theory for a long time. The sequence of events from a slight hepatitis to a pancreatic lymphangitis and chronic pancreatitis associated with a diseased gall-bladder is demonstrable almost daily in my clinics. Archibald claims that the inflammation in the pancreas may be due to the influx of bile into the pancreatic ducts, but experimental work by Mann and others, has shown that this does not occur except under exceptional circumstances, such as violent retching, vomiting, etc. In other words, the irritation comes from the lymphatics, the irritation causes stasis of infected bile and the stasis sets up the vicious circle between the liver, gall-bladder, pancreas and bile ducts.

The bearing of this on the surgery of the gall-bladder is readily seen in that neither the liver nor the pancreas have as yet permitted any direct surgical assault, and it is mainly through the gall-bladder that their disorders can be attacked.

Although with the passing years familiarity with the operation of cholecystectomy has removed the technical disadvantages of the radical compared with the conservative operation, nevertheless the discussion of cholecystectomy *versus* cholecystostomy goes merrily on, in fact seems to be undergoing some-

what of a revival at this time. It is not so much the immediate mortality of the two operations that causes the discussion, for in the hands of the expert there is practically no difference between the two, except that perhaps chole-cystostomy has a somewhat higher death-rate, due to the fact that most of the cases thus treated are more desperately ill than the ones subjected to cholecys-tectomy. The main question as to the relative merits of the two operations, to my mind, are the function of the gall-bladder and the end-results of the two methods.

That the function of the gall-bladder is not a very important one is readily seen from several facts: The diseased gall-bladder certainly does not func-tionate, nor does the retained cholecystostomized gall-bladder, bound down by post-operative adhesions, functionate; and furthermore, the majority of chole-cystectomized individuals get along remarkably well without the organ. Cholecystostomy, when there are no contra-indications to the radical operation, is a conservative operation mainly because it conserves the gall-bladder for probable future trouble. This is evidenced from the reports from various sources of the end-results of the two operations. In my experience from four to eight per cent. of the patients who have been operated for disease of the bile passages return for re-operation for symptoms of recurrence of the disease, and that of these about 80 per cent. have returned after a primary cholecystostomy. On the other hand, if the future trouble takes the form of common duct obstruction or of chronic pancreatitis, the retained gall-bladder may prove useful for making a cholecystoduodenostomy, the indicated procedure in such cases. But the question arises might not a primary chole-cystectomy have prevented such sequelæ. The most common cause of recur-rence after drainage of the gall-bladder is gall-stones, which have either persisted or have re-formed. Of course, it is not easy to determine whether the stones were overlooked at the first operation, but the impression is strong that they have re-formed, since many of the cases present so large a number of stones that it is scarcely probable that they could have been overlooked. Anyone familiar with gall-bladder surgery, however, knows how difficult it is to clear the two primary branches of the hepatic duct, and how readily it may happen that in attempting to do so, one or more stones may be pushed upward beyond reach and later cause common duct obstruction, for obstruction of the common duct is the most frequent finding in these re-operated cases. It is a well-established fact that in prolonged cases of symptoms of cholecystitis, the bile ducts become dilated and stones are apt to lodge in the recesses, so that they cannot always be detected or always removed at operation, and thus persisting, cause the recurrence of gall-stone symptoms. The best prophy-lactic for this is, of course, early operation before dilatation and irregularity in the lumen of the ducts have had a chance to develop.

The most frequent cause of recurrence after cholecystectomy is adhesions, and the most serious in my experience of re-operated cases is persistent chronic infection, involving the pancreas.

Adhesions cannot always be prevented even with the most careful technic, and must be accepted as a post-operative possibility. We cannot, however, so easily resign ourselves to the acceptance of chronic pancreatitis as a sequel to cholecystectomy. The condition is usually a pre-operative one and can be avoided in most instances by early attention to symptoms of gall-bladder pathology. Once established, chronic pancreatitis does not always yield promptly to treatment in these recurrent cases; in the absence of the gall-bladder, drainage through the common duct affords relief and often cure, but the outlook for a permanent cure is not altogether encouraging.

AMŒBIC LIVER ABSCESS

WITH A REPORT OF TWO CASES OCCURRING IN CONNECTICUT

By Maxwell Lear, M.D.

AND

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FROM THE SURGICAL CLINIC OF THE NEW HAVEN HOSPITAL

Introduction.—The occurrence of amœbic abscess of the liver in two patients, in conjunction with a small local epidemic of nine cases of amœbic dysentery in Connecticut, has brought to our attention a subject which has hitherto received but little consideration in countries not infected with tropical diseases. The clinical diagnosis and the treatment of this disease, as well as the climatology and pathology, have been most completely covered by Sir Leonard Rogers [1] in his Lettsonian Lectures, in which he based his conclusions on many cases, under observation for a long time, in that excellent clinic for tropical diseases, India. Ludlow,[2] Mebane,[3] and Hartmann-Keppel,[4] have also reported fairly large series from tropical and semi-tropical countries, but the present epidemic, as far as can be determined, is the first to be reported from Connecticut. The two cases of amœbic abscess of the liver herein detailed are therefore presented in order to call attention to the importance, even in regions supposedly free from amœbic disease, of considering the diagnosis of amœbic abscess of the liver in patients with obscure infection in the upper abdomen. In addition, the marked advantages of the treatment outlined by Rogers,[1] as compared with the methods which have been hitherto employed, will also be pointed out.

Local Epidemic.—The small epidemic of amœbic disease which occurred in Connecticut, consisting of nine cases, was localized within a suburb a short distance from New Haven, and has been completely reported by Blake.[5] Seven of the patients presented typical cases of amœbic dysentery, none of whom developed liver complications. The source of the infection was well localized by the Connecticut State Department of Health, and there has been no further spread of the disease. The two patients who were suffering from amœbic abscess of the liver did not give any previous history of intestinal disease, but were admitted to the New Haven Hospital with the symptoms of a subacute infection in the upper abdomen. Our report will therefore consider these two patients, and will duscuss the surgical diagnosis, and treatment of this complication of amœbic dysentery.

Diagnosis.—In general, the diagnosis of an unusual condition such as amœbic disease of the liver, receives from the profession a degree of consideration commensurate with the frequency with which it occurs in that particular geographical area. Thus, whereas solitary liver abscess should be considered first, in the differential diagnosis, if the patient were living in

India, Korea, or Panama, it is the condition suspected last, if at all, in temperate zones, where tropical diseases are an extremely rare occurrence. One has to depend, therefore, on all the factors generally available in establishing the diagnosis of any given condition, and these, together with the knowledge that uncommon diseases though rare, do occur, should be of considerable assistance in arriving at a correct clinical diagnosis.

The history of patients suffering from amœbic disease of the liver is one of a long-standing, debilitating infection, with or without chills, and most frequently accompanied by a diurnal elevation of temperature and marked diaphoresis. There is anorexia, loss of weight and asthenia, marked pallor, and rarely definite jaundice. The past history does not necessarily include attacks of dysentery, and from this point of view may be misleading. The physical examination demonstrates the points indicated by the history. The patient appears septic, and has definite dulness and tenderness over the liver region, in front and posteriorly, with a limitation of respiratory movements in some cases. There is a downward extension of the normal liver dulness for a variable distance below the costal
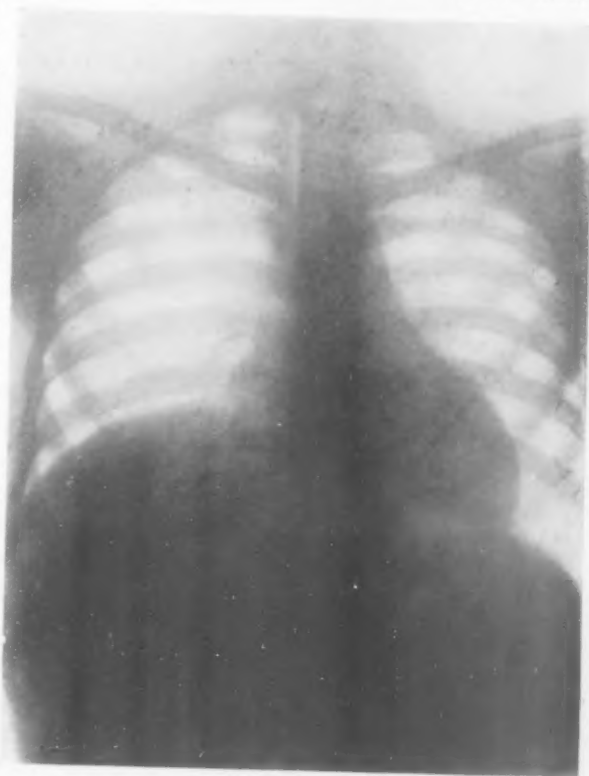
FIG. 1.—Case I. Plate of chest, before operation, showing high fixed diaphragm.

margin, but the rigidity of the abdominal wall makes actual palpation of the liver difficult. The laboratory examination is not consistently of assistance in establishing the diagnosis. The urine has no special significance in the disease. The stools may or may not contain cysts or amœbæ, so that the absence of this microscopic evidence, upon examination of the fæces, does not preclude a diagnosis of amœbic dysentery, neither does it rule out any of the complications of amœbiasis. The blood examination is not consistently indicative of the presence or absence of amœbic infection, the white cell counts varying from the normal up to 30,000. In the presence of a leukocytosis there is generally also an increase in the polymorphonuclear cells, but with no pronounced eosinophilia. Radiography can be of considerable assistance, and,

FIG. 2.—Case I. Chart of vital signs, showing striking temperature reaction following aspiration of abscess.

in the presence of a well-established liver abscess, demonstrates a fixed, elevated diaphragm with the preservation of the costo-hepatic angle. (Figs. 1 and 3.)

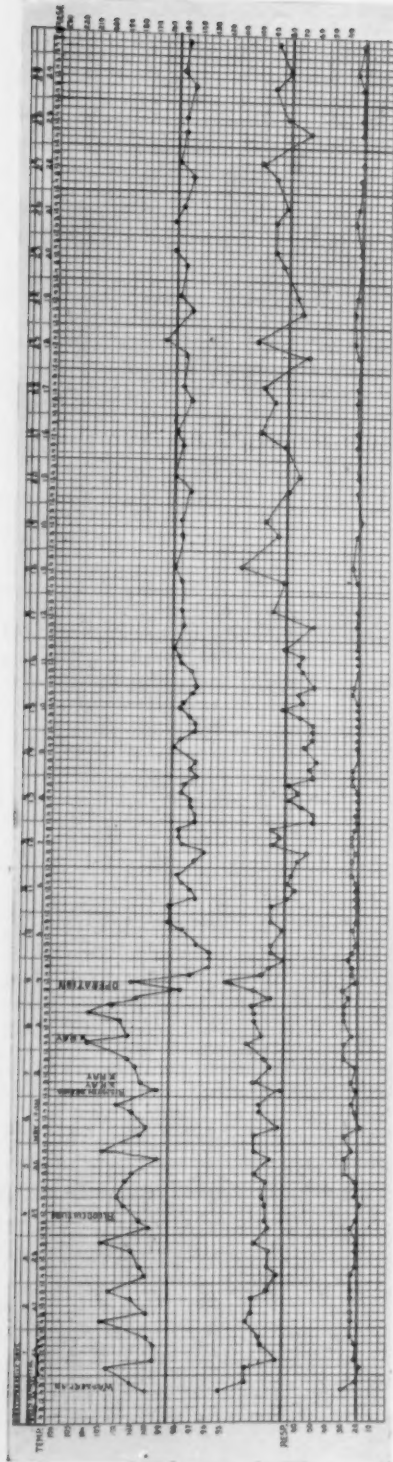Exploratory puncture of the liver is advocated by workers in areas infected with amœbic disease, and this procedure, in many instances frequently determines the diagnosis. The prevalence of amœbic disease in the tropics makes hepatic puncture a procedure as frequently employed as thoracentesis. Diagnotic liver puncture cannot, however, be advocated as a freely applicable measure in countries where the disease is rare, because of the dangers involved. Rogers[1] quoted Hatch as having reported six fatal cases of intraperitoneal hemorrhage following such puncture, in which no abscess was found post-mortem, the livers were in the pre-suppurative stage of hepatitis, and the disease could have been cured medicinally. Such results should tend to discourage a diagnostic puncture of the liver, and where this disease is uncommon it would be preferable to make a small exploratory incision, particularly in the absence of a definitely established diagnosis. With open exploration the character of the disease in the upper abdomen can be established with safety, and the liver can then be punctured and aspirated, either at the same time, or at a later period, through an artificially established and well walled-off sinus. Such a procedure can be carried out with a minimum degree of shock to the patient, and certainly without the hazard of fatal intraperitoneal hemorrhage from the liver.

Treatment.—The most important phase of the subject for consideration in this report is the method of treatment of amœbic liver abscess, as it is on this question that there is such a wide diversity of opinion.

LUDLOW [2] in reporting his one hundred cases, in which he advocated open incision and drainage for the treatment of amœbic liver abscess, made reference to the possibility of the conservative method of aspiration in conjunction with the use of emetine. However, he employed the aspirator for the diagnosis only, in sixty of his cases, and the open incision and drainage of the abscess cavity in the liver for the actual treatment. Hartmann-Keppel, [4] in twenty-two patients, resorted to emetine treatment, with or without therapeutic aspiration, while in some instances he employed open incision and drainage of the liver substance. His conclusions placed great importance upon the rôle emetine played in the prevention, arrest and ultimate cure of amœbic liver abscess. He also emphasized the failure of surgery, namely, incision and drainage, in the two patients in whom emetine was not employed. In addition he pointed out the importance of a guarded prognosis, in reference to complete cure, because of the frequency of recurrences even in the most carefully treated cases.

MEBANE, [3] in fifty cases reported from the Government Service in Panama, in which the mortality rate was " more than one-third," advocated the open treatment by tube-drainage and frequent irrigations. The mortality rate, as in other series which have been reported, was more or less influenced by the condition of the patients at the time of operation, and those who were moribund would have died even under the most conservative method of treatment. Mebane's [3] statistics, however, are very similar to others in which the operation of incision and drainage of the liver substance was employed.

Rogers, [1] in a complete review of the problem from every point of view, arrived at the conclusion that incision and open drainage of amœbic liver abscess was incorrect in principle, and his argument becomes irrefutable when one considers the large amount of material which he studied. His conclusions were based on two principles.

1. As soon as the fibrous wall of the liver abscess is formed, the destruction of the liver tissue is halted. This quiescent state prevails, as long as there is not superimposed a secondary pyogenic infection in the abscess cavity. He established this point more clearly by comparing the relative innocuousness of an amœbic abscess of the liver containing eight pints of amœbic pus, with a small pyogenic abscess in the same liver, which followed the open operation, and which caused the death of the patient from sepsis. Rogers [1] quoted Spencer, of the Royal Army Medical Corps, who stated that " the chief cause of the high mortality in this condition (liver abscess), is the secondary infection of the abscess cavity through the open wound," after the abscess has been incised and drained. In proof of this, Rogers cited the fact that 86 per cent. of cultures from the pus obtained in amœbic liver abscesses of the liver was sterile at the time of aspiration, and that the bacterial growth in the remaining 14 per cent. was possibly due to incidental contamination, whereas the same patients, several days after the open operation, were all harboring a secondary pyogenic infection in the previously uninfected abscess cavity.

2. The mortality of the aspiration method, as compared with that of the

open operation, was strikingly brought out in Table I of Rogers' report.* In this table, representing a series of two thousand six hundred and sixty-one cases, from seven institutions, the open operation was employed with a mortality of one thousand five hundred and eleven, or 56.8 per cent. On the other hand, in a series of one hundred and eleven cases, treated by aspiration, and medication with either ipecacuanha or emetine, there were sixteen deaths, or 14.4 per cent. It is interesting to note, that among the series treated by the aspiration and medication method, there were patients of Thurston and Chatterji, who had also contributed to the earlier series treated by the open drainage method. Thurston's groups represented forty-five cases with eighteen deaths by the open method, and forty-eight cases with eleven deaths by the conservative aspiration method, showing a decline in mortality from 40 per cent. to 23.3 per cent., in parallel series, by the same worker.

These two related arguments can certainly point in only one direction, namely, that aspiration of the liver abscess cavity by the closed method obviates the danger of secondary pyogenic infection, and that the combined treatment by closed aspiration and emetine gives better results than the open operation of incision and drainage of the liver substance.

The development of the medicinal treatment of amœbic disease of the liver was very well summarized by Rogers, and he traced its evolution from early European practice in 1658, and its first use in India in 1660, down through the work of Abercrombie, Twining, Annesley, Maclean, Docker, Parkes, Chovers and Manson, beginning with the early empiricism, and going through the uses of ipecacuanha, antimony, ammonium chloride, quinine, and and finally the refined alkaloid of ipecacuanha, emetine.

The treatment advocated by Rogers, therefore, very definitely improved upon the more radical open method, and the results of this rationale appeared particularly applicable to the well-established case of solitary liver abscess of long standing. Our two cases strikingly illustrated the distinct advantages of the procedure, and in these patients, the exploratory exposure of the liver, previous to aspiration, was necessarily diagnostic as well as therapeutic, and appeared to be the safer method to employ in a climate where tropical diseases are rarely seen. Although in our second case the possibility of amœbic liver abscess was considered, it did not appear safe in either of the patients to perform a blind exploratory hepatic puncture, particularly in view of the degree of debility in which they came to us. In both cases, a single aspiration and a double course of hypodermatic injections of emetine, to be detailed later on, proved sufficient for a cure, and to date both of our patients have been free from any recurrence. Both exploratory incisions were performed under a light gas and oxygen anæsthesia, and although the procedure produced a minimum of operative shock, it obviated the danger of blind puncture and the consequent intraperitoneal hemorrhage. A detailed report of both cases follows.

* Table I, A; p. 574.

AMŒBIC LIVER ABSCESS

CASE REPORTS

CASE I.—H. N., male, age thirty-six, a laborer, born in Greece, was admitted to the medical service of the New Haven Hospital on April 25, 1922. At the time of admission the patient complained of pain in the right side.

History.—The patient had been well until January, 1922, at which time he noticed that he tired easily and had marked loss of appetite. Toward the end of February, 1922, he began to suffer from a severe pain in the right upper quadrant of the abdomen. The pain was not lancinating in character, and did not radiate in any direction, but was fairly constant. There was no jaundice, no nausea, no vomiting, no diarrhœa and no cough. There were no definite chills, but he had an afternoon temperature and profuse night sweats. His condition grew gradually worse, and at the time of admission to the hospital he was quite asthenic, and had lost about twelve pounds in weight. There was no previous history of similar attacks of pain, jaundice or dysentery and no important urinary history. There was no history of lues, and the family history was also negative.

Physical Examination.—The patient was a poorly nourished man with a sallow complexion but without jaundice, and he appeared quite definitely septic. There was no general glandular enlargement. The examination of the heart and lungs was essentially negative. On abdominal examination, the point of interest was the right upper quadrant. Here the liver dulness began at the fifth rib and extended downward to about 3 cm. below the costal margin, in the nipple line. The mass below the costal margin moved with inspiration but could not be definitely identified as the edge of the liver. The remainder of the abdomen was essentially negative. There were no other positive points in the physical examination.

Vital Signs.—Temperature, 100° F.; pulse, 120 per minute; respirations, 20 per minute.

FIG. 3.—Case II. Plate of chest, before operation, showing diaphragm, fixed and higher than in Case I.

Laboratory Examination.—Red blood-cells, 3,632,000; white blood-cells, 8600, with 75 per cent. polymorphonuclears, 18 per cent. lymphocytes, 7 per cent. large mononuclears, and no eosinophiles. Hæmoglobin, 60 per cent. The red cells showed a general achromia, but there were no other positive findings in the blood. The urine and the stools were negative. Blood culture, Widal, and Wassermann were negative. X-ray examination showed a moderately elevated right diaphragm and an enlarged liver (Fig. 1).

The temperature continued to range between 100° and 103° F., with a corresponding fluctuation in the pulse and respirations, and on the eighth day after admission the patient was transferred to the surgical service, and was operated upon on the following day.

Operative Note.—After the usual skin preparation, and under gas-oxygen anæsthesia, the right upper quadrant of the abdomen was opened through a high split right rectus incision. The anterior wall of the stomach presented in the incision, and a band of
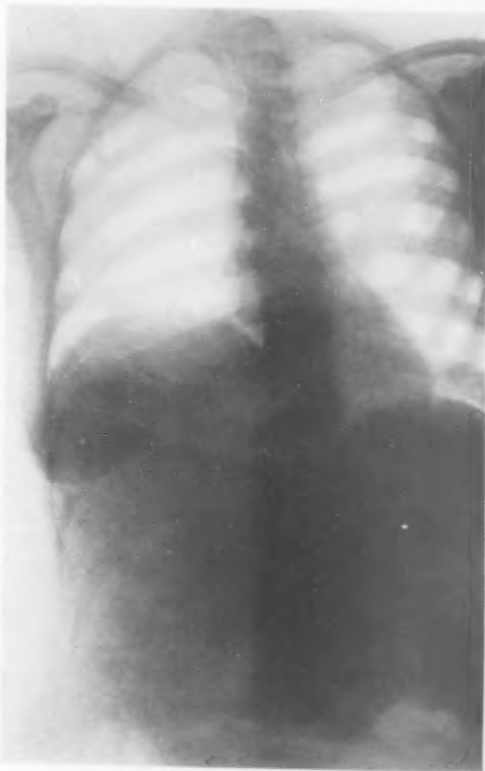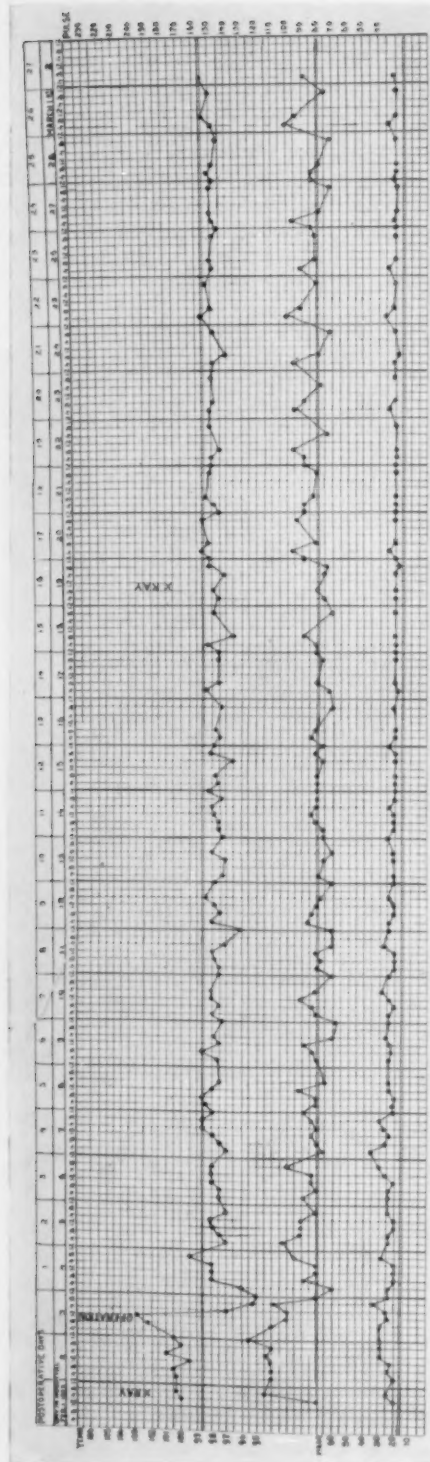
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Fig. 4.—Case II. Chart of vital signs, showing sharp drop in temperature and pulse, following evacuation of abscess.

adhesions which extended from the pyloric end of the stomach toward the gall-bladder was divided. Exploration showed the stomach and first portion of the duodenum and the gall-bladder to be of normal appearance and consistency. The gall-bladder wall was not thickened and there were no stones palpable. The head of the pancreas was palpated through the foramen of Winslow, and nothing abnormal was found. The liver extended about four inches below the costal margin. The lower portion of the right lobe was of fairly normal consistency, but when the hand was passed up over the surface of the right lobe, a definite ring of induration was felt which was approximately twelve centimetres in diameter. The liver substance at the centre of the ring of induration felt rather boggy. A dull aspirating needle, on a twenty c.c. Luer syringe, was inserted into the soft portion at the centre of the ring of induration above described, and at a depth of about three or four centimetres beneath the surface of the liver, a thick, reddish chocolate-colored pus was obtained, which had a faint milky odor. About 1200 c.c. of this material was withdrawn and the needle was then removed. The abdominal wound was closed in layers, and its upper angle was packed with a strip of gauze which extended down to the liver surface at the site of aspiration. This packing was placed in order to establish a small, walled-off sinus tract down to the liver surface through which further aspiration might be carried out in case it should become necessary. The patient stood the operation very well, and was returned to the ward in good condition. Soon after being returned to the ward his temperature dropped from 101.5° to 96.2° (Fig. 2). He received his first dose of emetine hydrochloride, gr. ½ hypodermatically, at this time, and within about thirty hours his temperature became normal and fluctuated just below the normal line until his discharge from the hospital, twenty-one days after operation. The pulse curve also remained about the normal average throughout his convalescence. No further aspiration appeared necessary.

Post-operative Course.—The pus which was aspirated from the liver abscess showed no amœbæ or cysts. The stools were consistently negative for amœbæ, and the patient received one grain of emetine per day for seven days following operation. This course was followed by a period of rest of one week's duration, and then a second course of emetine, one grain per day, totalling seven grains, was given. His symptoms entirely disappeared, his general condition improved, and when discharged from the hospital he was definitely gaining in strength. He reported back to the out-patient department several times during the following month, at the end of which period his general condition was excellent. He was requested to return to the hospital for reëxamination, and appeared on April 27, 1923. At this time, about eleven months after the operation, he had gained twenty pounds and had been perfectly well during the entire period. The physical examination showed the liver dulness to be within normal limits, with the lower border of the area of liver dulness at the costal margin and the edge not palpable. Examination of the stools at this time was also negative for amœbæ.

CASE II.—M. C., female, age thirty-five, a housewife, born in Italy, was admitted to the surgical service of the New Haven Hospital on February 1, 1923. The chief complaint on admission was that of pain in the right side of the upper abdomen.

History.—The patient's illness dated back for about eleven months, to March, 1922. At that time she had had an attack of pain in the right upper quadrant of the abdomen, which was accompanied by general weakness and gastric distress, including nausea, vomiting, and pyrosis. There was no other intestinal disturbance, and the bowels were perfectly regular, with the stools showing nothing remarkable. There was no jaundice, and at the time of onset of the illness the pain did not radiate. This condition continued for about six months, and in September, 1922, the patient had an exploratory laparotomy performed in another hospital. The operative findings, as far as they could be ascertained, were negative, and the gall-bladder, appearing normal, was not disturbed. The appendix, which was bound down by adhesions, was removed. The post-operative course appeared to be uneventful, but the symptoms, of which the patient originally complained, persisted. At this time, the pain began to involve the axillary portion of the right chest and also radiated to the right shoulder. The malaise and weakness increased, and the patient began to have a daily elevation of temperature, with night sweats. The nausea and vomiting continued, and at the time of admission the patient had lost about twenty-five pounds. The past history showed nothing important, except that there was no history of any intestinal disturbance, simulating dysentery, at any time within the patient's memory.

Physical Examination.—The patient was a poorly nourished, dessicated, woman who appeared quite septic. She complained of severe pain in the right upper quadrant, and the lower right chest. There was no jaundice; the heart was negative; the left chest was also negative. There was marked tenderness in the right upper quadrant, anteriorly and posteriorly, which began at the eleventh rib in the posterior axillary line, and extended downward to the level of the umbilicus. The lower portion of the right chest was dull to percussion, and the breath sounds were suppressed from the fourth rib downward in front and in the axillary region. The area of dulness continued downward to about the level of the umbilicus and appeared to be due to the displacement or extension of the liver downward. The entire region described was tender to palpation, but there was an area of extreme tenderness in the right costovertebral angle. Otherwise the abdomen was negative.

Vital Signs.—Temperature, 100° F.; pulse, 110 per minute; respiration, 20 per minute.

Laboratory Examination.—Red blood-cells, 4,400,000; white blood-cells, 10,920, with 64 per cent. polymorphonuclears, 32 per cent. lymphocytes, 4 per cent. large mononuclears and no eosinophiles. Hæmoglobin, 90 per cent. The urine was negative; the stools were not examined.

X-ray Examination.—The lungs were clear, but the right diaphragm was at the third interspace, dome-shaped, with marked fixation (Fig. 3). Within the next thirty-six

hours the temperature rose to 103°, with a corresponding elevation in the pulse and respirations. An exploratory operation of the right upper abdomen was then decided upon, with a tentative diagnosis of subphrenic abscess.

Operative Note.—After the usual skin preparation, and under gas-oxygen anæsthesia, a right sub-costal incision was made, parallel to the eleventh costal margin and continued down through the peritoneum. A small amount of clear straw-colored fluid presented, which had no odor, and was apparently simple transudate. Careful digital palpation through the peritoneal opening showed that the edge of the liver was adherent to the parietal peritoneum in every direction examined by the exploring finger, so that the general peritoneal cavity was completely walled off. The liver was the only intraperitoneal organ present, and the gall-bladder and colon lay below the line of adhesion. Laterally, the kidney was palpable and it did not seem to lie abnormally. Digital exploration upward showed the lower margin of the liver to be free and soft for about two and a half finger's breadth, but from this point upward, toward the dome of the liver, the entire organ was very hard, with the area of induration definitely localized and outlined. A dull aspirating needle was introduced into this indurated area, and after penetrating about four cm. of hard liver substance, a thick, reddish-brown fluid was obtained, and of this about 400 c.c. was aspirated. The fluid had a faint milky odor and was homogeneous in consistency. The aspirating needle was withdrawn, and a wide strip of gauze tenting was placed in the posterior angle of the wound, down to the point of aspiration along the anterior surface of the liver, in order to establish a walled-off route for further aspiration, should any become necessary. An additional stab wound was made in the ninth intercostal space in the anterior axillary line, and this was also packed with gauze down to the surface of the liver, in order to obtain a more direct route for aspiration for future use. There was no operative shock; the remainder of the wound was closed in layers, and the patient was returned to the ward in good condition. Immediately upon being returned to the ward her temperature dropped from a pre-operative 103° to 95.5° (Fig. 4). She was kept warm, and within about twelve hours the temperature gradually rose to normal.

Post-operative Course.—The wound healed *per primam*. Amœba histolytica was identified in the stools on February 4 and 5, but repeated examinations thereafter up to March 2, 1923, the day of discharge, showed no amœbæ in the stools. The patient received two courses of emetine hydrochloride, consisting of one grain per day for seven days, an interval of rest for one week, and a second course of seven days similar to the first one. The vital signs remained around normal throughout her convalescence, and she was discharged on March 3, forty-eight days after the operation, completely cured. The patient was reëxamined on April 27, 1923, and at this time, somewhat less than three months since operation, she had gained about twelve pounds, was in excellent general condition, and had had no recurrence of symptoms. The chest examination was negative; the edge of the liver did not extend below the costal margin, and the stools were negative for amœbæ.

SUMMARY

1. Amœbic abscess of the liver is reported for the first time in Connecticut, coincident with a small epidemic of amœbic dysentery.

2. The definite diagnosis of solitary amœbic liver abscess was in both cases established by exploratory laparotomy and aspiration. In climates where tropical diseases are uncommon, this procedure is safer than a blind hepatic puncture.

3. Rogers' method of treatment by aspiration and systemic emetine medication is productive of better results than the open incision and drainage

method. In the latter procedure, failure is due to secondary pyogenic infection of the abscess cavity.

4. A striking drop of the temperature to subnormal, immediately following the operation, was noted in both of the cases herein reported.

5. Neither of our patients required repeated aspiration, and to date there has been no evidence of recurrence.

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TRANSVERSE INCISION AND DEPENDENT DRAINAGE IN APPENDICITIS*

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Proposed operations based on plausible theory, supported as they frequently are by a limited clinical experience, have a definite place in surgical literature. Only too often when more extensively tried and found wanting, abandoned even by their authors, or supplanted by improvements, there is no one to expunge the record which remains with the possibility of a disadvantageous retrial. Conversely an inadequately described or misunderstood plan of real merit may be overlooked.

In November, 1905, in the New York Medical Record, in an article on "Transverse Incisions in Abdominal Operations," I proposed, after a brief trial, the removal of the appendix through a transverse incision across McBurney's point, the outer end being just above the anterior iliac spine.

In January, 1906, in the Annals of Surgery, Gwilym Davis, of Philadelphia, described a transverse incision for appendicitis. In response to a reprint of my paper, which I sent him, he wrote, that in the mass of surgical literature he had overlooked my communication, but trusted that together in time we might teach the profession that this method had definite advantages.

It will be evident by reference to the original papers that neither Davis nor myself fully comprehended the possibilities of the plan. Shortly after the publication of Gwilym Davis' paper he gave up general surgery for orthopædics, and in 1918, to the great loss of surgery and all that it means in the relief of human suffering, he was taken by an untimely death. My subsequent paper before the Surgical Section of the American Medical Association in 1915, was without illustration. If apology is due for again calling attention to this procedure in the light of a continued and larger experience, it would be that the incompleteness of previous presentations has left an unfulfilled duty.

Although the external picture of the transverse incision does not readily appeal to the surgical imagination, if the operator will examine critically salient points of the surgical anatomy, he will be encouraged to venture on a method that I have never known anyone to abandon after it had been understandingly practiced (Fig. 1). The oblique and transverse abdominal muscles have broad aponeuroses, the latter uniting and blending at the outer border of the sheath of the rectus, spreading over it anteriorly, and to a more limited extent posteriorly. The aponeurosis of the external oblique is the longest of the three. At the line of incision the fibres of the transversalis and internal oblique muscles are directly transverse, and the internal oblique, though vary-

ing a few degrees, is further cut, and so soft that the variation is of no consequence in operation. After the transverse incision is carried through the skin to the deep fascia directly across McBurney's point, the inner end should be over the belly of the rectus, and the o u t e r just a b o v e the iliac spine in the flank (Fig. 1). T h e length of the incision w i l l, o f course, vary with the requirements of the case. The only part then cut i s t h e r e c t u s sheath, the aponeurotic junction at its outer border, and the aponeuroses of the muscles. The incision is then spread wide open by an up-and-down pull, like opening the drawstring of a purse, separating t h e muscle fibres, and exposing a surprisingly l a r g e area of peritoneum (Fig. 2c).

The up-and-down p u l l t o open the incision
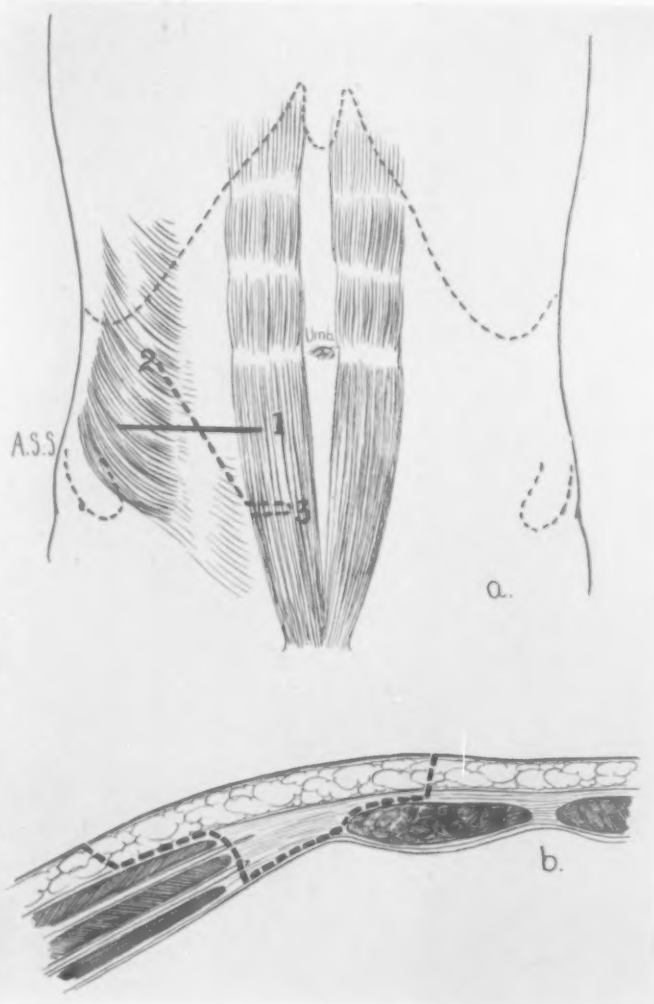
FIG. 1.—a. Surgical anatomy showing relation of the author's incision to those of McBurney and Wier. b. The tissues incised before making the exposure of the peritoneum, by spreading the incision and introducing retractors, are shown above the dotted line.

is of major importance in the performance of this operation. The actual cutting is confined entirely to the fascia of the rectus and the aponeuroses of the muscles. This is the key which prepares for the opening which is made by the vertical pull. It is difficult to illustrate this. If I could project a mental picture of it on the screen of surgical comprehension, the percentage of transverse incisions, especially in pus appendix operations, would rise near the top instead of remaining so long near the bottom.

There is very little bleeding and nerves are not severed. Retractors are then placed at the inner and outer ends of the incision, drawing the rectus well into its sheath, and unifying the obliquity of the soft muscles at the
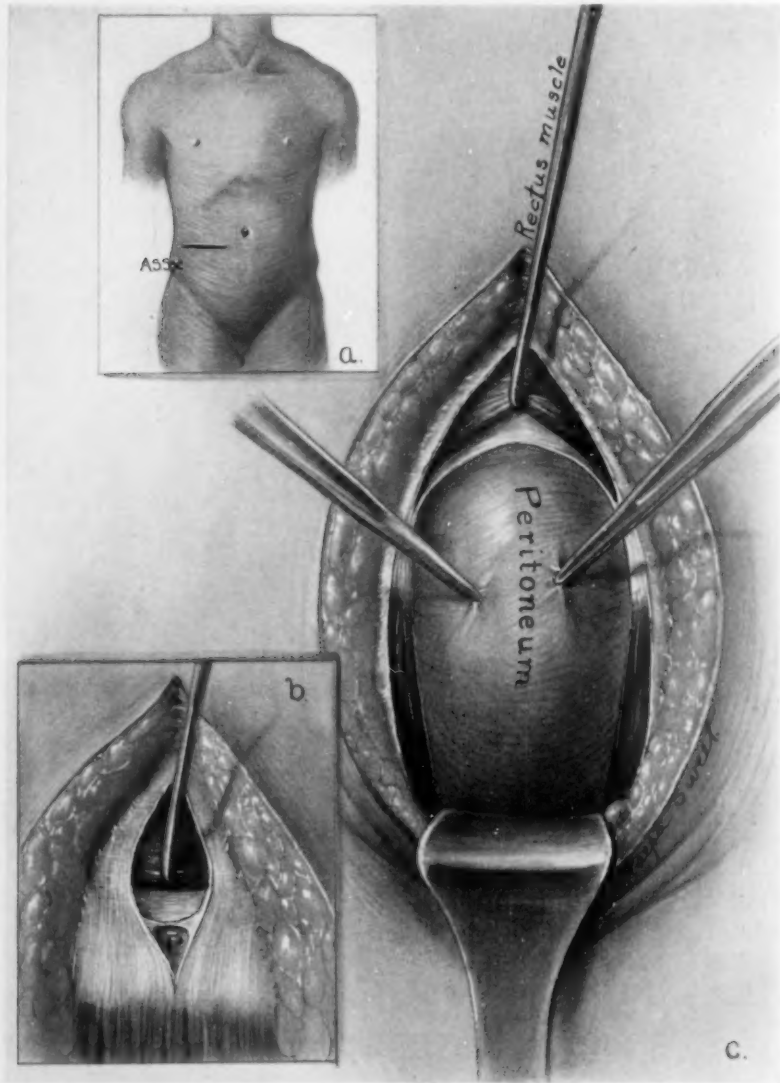
FIG. 2.—*a.* Surface location of the incision. *b.* The key at the inner border of the rectus. *c.* The peritoneal exposure.

outer side. This opening may be made in about half the time required for any other incision. The only part cut with the knife is that above the dotted line in Fig. 1b. The resulting peritoneal exposure is illustrated in Fig. 2c. For the necessity of anatomical clarity the inner retractor is represented by a hook in the illustration. The peritoneum is now incised on the same line, and if desired the retractors may be introduced within the

FIG. 3.—Delivery of the appendix.

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cavity. This should be done with caution not to overexpose the viscera particularly at the inner end. When this is observed as it should be in purulent cases, the small intestine is seldom seen in the operative field. Retrocæcal and extreme lateral position of the appendix furnish a large proportion of suppurative cases. This may be for the reason that in this position the appendix has failed to follow the cæcum in that complete rotation that constitutes normal position. It is consequently more likely to be abnormal in shape, and to offer obstruction to escape of normal secretions or to fecal intrusion. This in turn sets up an irritation that predisposes the appendix that is retrocæcal, or in lateral position, to inflammatory attack. I have no statistics on this point available, but the recollection of my personal experience would lead me to believe that this is true.

In almost all others except the extreme pelvic (2 or 3 per cent.), the appendix after detachment of adhesions can be lifted into the open incision by the finger without exposing the small intestine (Fig. 3). Pelvic position in an acute appendicitis can usually be diagnosed before operation. In that position the vertical mid-rectus incision should be made.

Diagnosis is as yet not entirely an exact science. It may well be that the condition revealed through the transverse incision may make some other approach more suitable. The time consumed, and the anatomical disturbance, have been minimal. The incision may be either abandoned or enlarged, as the case requires. By carrying the superficial part of the incision only to a desired extent through the fascia of the rectus toward the inner border, it may be extended either up or down, without violating the rules of good surgery in dividing nerves supplying the muscle.

In the great proportion of cases there is no packing with sponges to wall off the unaffected cavity. The higher outer approach is the most direct to the seat of trouble. The centre of the incision is across McBurney's point, which continues as truly to indicate the average location of the base of the appendix as when it was marked by that master surgeon. Whatever the direction of the tip may be, this is the centre of surgical action. This being so, the purse-string or ligature may be applied with ease to the protruding cæcum without bringing it forward from an infected to a clean field.

The lower border of the mesentery extends from the midline of the body outward to the cæcum and appendix. The small intestine is always at the inner side. To locate the appendix, if it is not directly under the opened incision, insert the finger downward against the anterior wall of the cavity. Pass it outward under the end of the cæcum, and then backward against the posterior wall, and then bring it upward and forward, when it will curve under the free border of the mesentery, and locate or bring with it the cæcum and appendix (Fig. 3).

Non-suppurative cases, or those where pus is still confined within the appendix, need give but little concern. Recovery is usually uneventful with any type of operation. In purulent cases the result may be different. The term purulent must be taken to mean not only gross pus, but the flocculent,

grumous, peritoneal exudate, commonly foul smelling, that is seen in the early stage of the more acute gangrenous appendices. There is greater need for dependent drainage of a septic fluid of this sort than there is for gross pus. Such fluid may precede the protective distention and adhesion of milder types, and for the first twelve hours dependent drainage is of the highest importance.

Drainage that is really dependent must be from the bottom of the cavity. Capillary drainage may come from any point within the range of capillary attraction. Drainage by point of least resistance will come when other avenues of escape are relatively obstructed. This is what takes place when a confined collection of pus is opened during the performance of an operation. All three of these factors enter into the mechanics of abdominal drainage.

The type of drainage varies with the changing conditions incident to disease and repair by healing. When a cigarette drain is inserted into a pus cavity, it is immediately active by capillarity. The efficiency of the capillarity begins to diminish from the first moment. This is due to the blocking of the meshes of the gauze by the corpuscular elements, and by the coagulation of fibrin. This short period of capillary drainage is often of great value. It permits intestinal distention and temporary adhesion to block the way to inward spread of infection, and drainage then takes place around the outside of the obstructed cigarette, which then becomes the point of least resistance. The cohesion of the smooth drain with the tissues offers less resistance than the temporary adhesion of the distended intestinal coils. To permit least resistance drainage to be efficient, the drain must be loose. The last stitch around the drain had often better be left untied. When now we have dependent position added to least resistance point drainage, we have the most efficient type, and the one that will so continue for the maximum time.

There are two periods incident to the surgery of suppurative appendicitis when dependent drainage is of vital importance. The first is during the performance of the operation. Take the very common location of an appendiceal suppuration at the outside of the cæcum. Let us visualize the operation just described. When the peritoneum is exposed as illustrated in Fig. 3, and then incised as indicated, taking great care to begin at the outer end, the confined pus may be liberated without any exposure of the unaffected cavity. When the point of least resistance is in the dependent part, the first important life-saving step of the operation has been accomplished. The operation may end here with drainage, but with a much greater degree of safety than by any other approach it may be completed by the removal of the appendix and dependent drainage. The purse-string suture should not be used in many suppurative cases. The manipulation necessary to place it endangers an unwarranted extension of the infected field. The wall of the cæcum may be too inflamed. A simple ligature of chromic catgut fills the requirement. We may then place cigarette drainage, bearing in mind the limitations of efficient capillarity just described, or we may at once utilize a piece of glove wrist as illustrated. The other period is when the capillarity of cigarette drainage
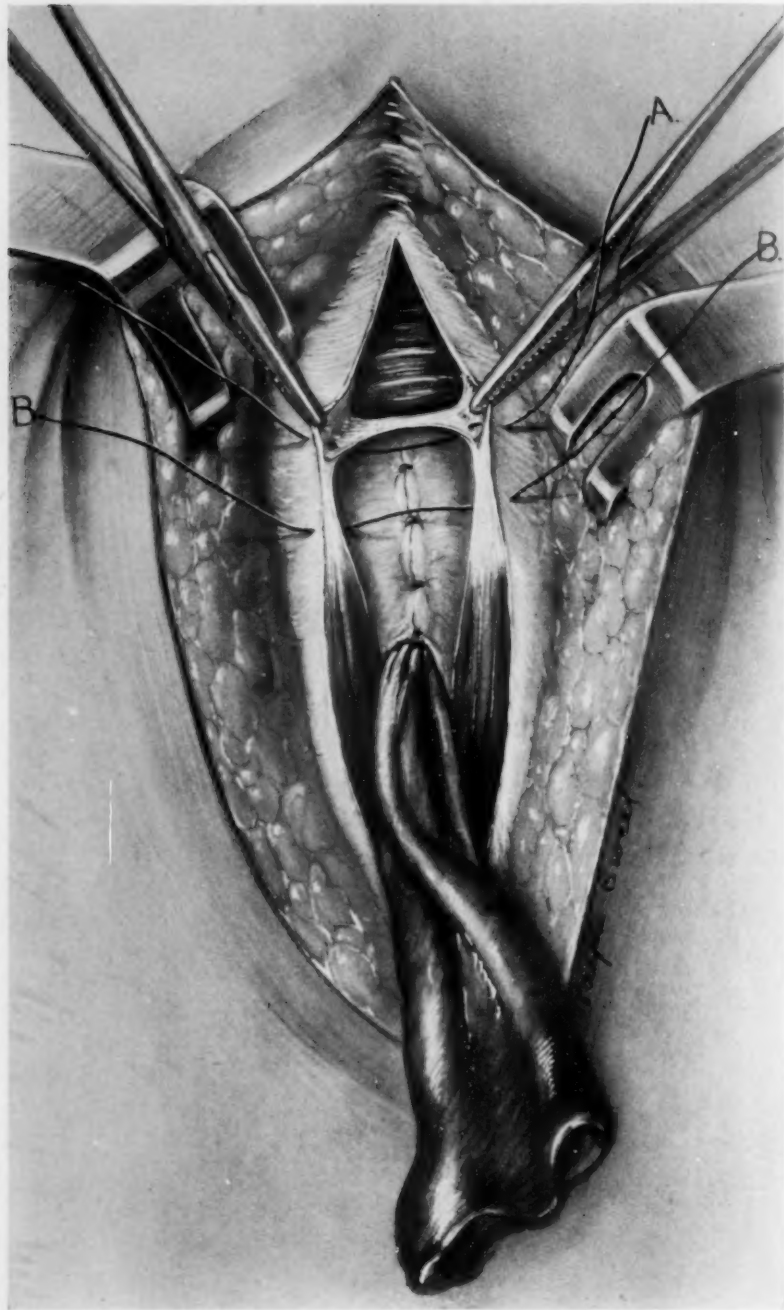
FIG. 4.—The drain has been placed, the peritoneum closed loosely above it and the key sutures introduced ready to be tied.

ceases to be efficient, and it must come around the drain instead of through it. Here true dependency added to point of least resistance is an important factor of safety.

Efficient dependent drainage may be secured only by placing the patient in such position that the point of drainage is in the lowest part of the cavity. This may be obtained with the patient resting comfortably on the side, and can be secured through the outer end of a transverse incision (Fig. 6). In pus cases requiring drainage the question of physical comfort may be exceedingly important in conserving the vitality of the patient. The transverse incision utilizes the same plan of opening the sheath of the rectus that had been previously proposed by Wier as an extension of McBurney's incision, but at different levels, and requiring a different drainage position. The lines of these incisions and their relation to each other are shown in Fig. 1. In the ordinary semi-sitting position, the entire basin of the pelvis, and part of the flank, are below the lower end of the incision.

In a comprehensive paper on " Drainage in Appendicitis " by Elbert J. Rulison, Jr., of New York, in the ANNALS OF SURGERY for December, 1919, there is a critical analysis of 263 cases, done at the Presbyterian Hospital, that required intraperitoneal drainage. The types of incision used were McBurney's 176, Wier 43, right rectus 30, median 9, Rockey's 3, Kammerer 2, additional stab wound in flank for dependent drainage 10. We believe, however, that in the average general practice the vertical right rectus is more used than these statistics would indicate.

It will be observed in Rulison's table that a flank stab wound for dependent drainage was made in ten cases. This is just what the transverse incision provides in all cases. A stab wound in the flank will not, however, give complete dependent drainage if the patient is prone on the back. The posterior pelvic brim forms a barrier. Instead of the inefficient, incomplete drainage in an uncomfortable elevated position, the transverse incision provides efficient, dependent drainage in a comfortable, lateral position that most persons assume in normal sleep. In this lateral position, with the upper part of the trunk slightly raised, and comfortably supported on two or three pillows, there are two inclined planes sloping toward the flank, the abdominal downward from the diaphragm, and the pelvic downward from the bottom of the pelvic basin, meeting the upper plane at the outer end in the flank, which is then the lowest point in the abdominal cavity, with the patient in the most comfortable position (Figs. 6 and 7). If drainage from the region of the diaphragm seems more indicated, the head of the bed may be raised on six-inch blocks without overcoming the downward drainage from the side of the pelvis.

This position admits of considerable variation in posture without impairing the efficiency of dependent drainage. These changes do much to relieve the irksomeness of any fixed position. The chest and shoulders may be turned forward or backward, varying the position of the arms, and the lower limbs may be placed as in Sims' position, or both drawn up together or extended, or the right thigh may be drawn up and the left extended. The pelvis may
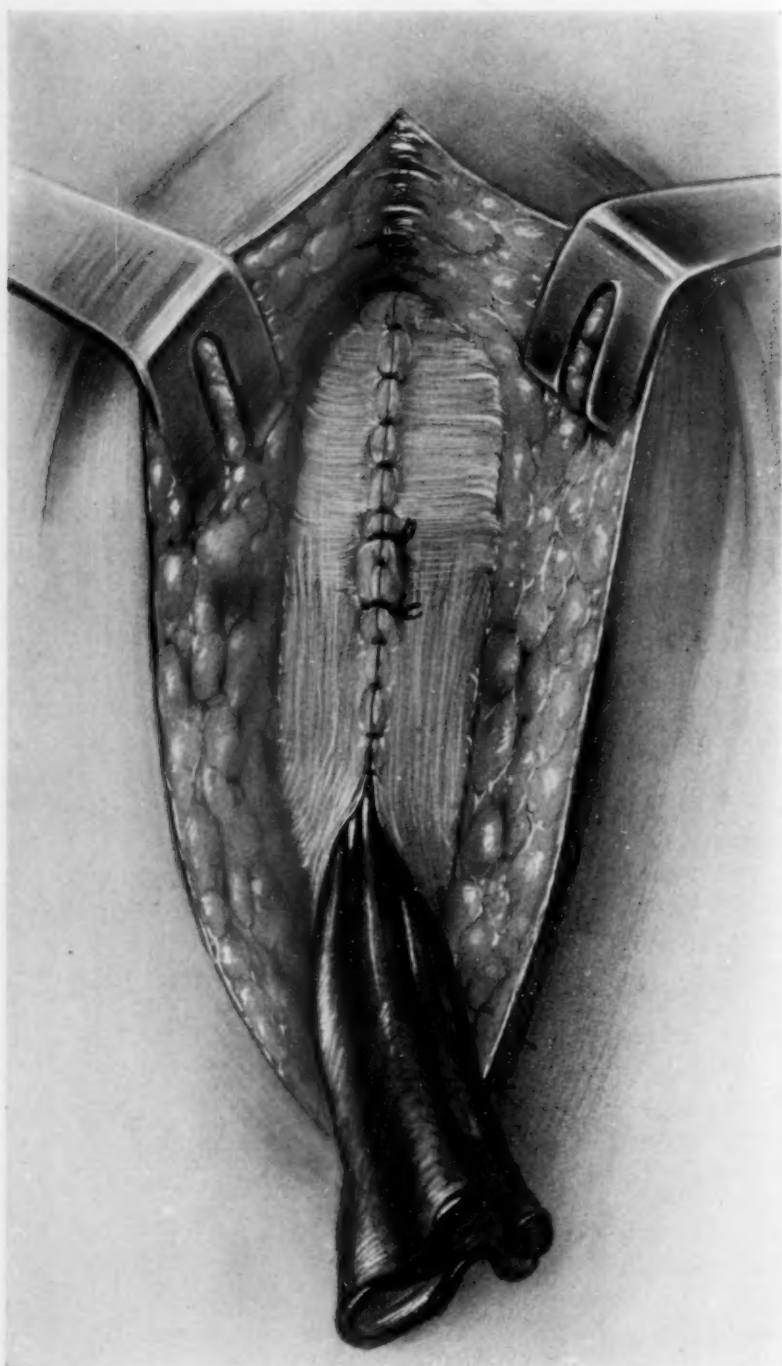
FIG. 5.—Key sutures tied. Fascia closed.

be tilted through an arc of 40°, and the right flank will still be the lowest point in the cavity. The vital time for complete dependent drainage is immediately after operation. After one to several days, when distention first and adhesions later have limited the spread of septic fluids, the position of the patient may be advantageously varied as illustrated in Figs. 6 and 7.

At this stage caution should be observed not to begin too early with efforts
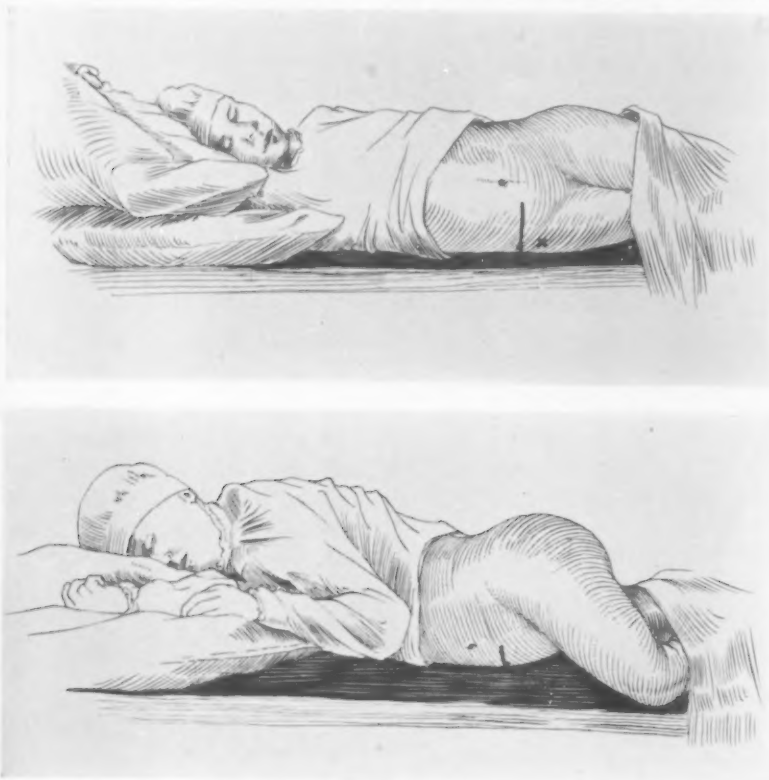
FIGS. 6 and 7.—The lateral position for dependent drainage, showing variations for comfort.

to stimulate peristalsis. It is best to endure for a while the discomfort of tympanitis with its advantageous blocking of the uninfected peritoneal surfaces, and the production of autogenous antibodies.

The important feature of the closing is what we call the " key " sutures (Fig. 4a and b). These should be of chromic gut No. 2. Two are placed about 5 mm. apart through the aponeuroses at the outer border of the rectus. When they are tied, the incision is practically closed. We, however, suture the sheath of the rectus, and the cut aponeuroses, and place a few stitches in the muscles. With drainage the aponeuroses are sutured, and one or two through the minor part of the muscles, having a care not to close too tightly about the drain. In the very septic type it may be well to insert heavy silkworm in figure of eight in addition to the chromic gut key sutures, and pass

the outer end through a short piece of Dakin tube in the standard way, but leave them untied until the caustic virulence of the sepsis has subsided. Hernia is very rare after operation by this method, and then only where the virulence of the infection has caused sloughing of the fascia. When it does occur, a sufficient time for the subsidence of residual infection should be allowed to elapse before any attempt is made to repair it.

I bespeak for this method of incision and dependent drainage a trial in the worst of suppurative cases. Its superiority in these will soon demonstrate its special fitness for the majority of others, until its general use will become a routine, as it has with me for more than eighteen years.

RECURRING HERNIA OF THE DIAPHRAGM*

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of Fall River, Mass.

Three operations upon the same individual for traumatic hernia of the diaphragm within a period of three years have provided rare opportunities for observation. The subject of this series of mishaps, a boy of five years, was run over by an automobile on May 11, 1920. One wheel of a touring car passed over his upper abdomen producing a rupture of the diaphragm on the left side. The condition was not discovered until January 24, 1921. To relieve obstruction of the intestine we operated by the transthoracic approach on February 23, 1921. This case with one other of similar origin in a child of three and one-half years I reported before this society in June, 1921. Doctor O'Connell, of Providence, R. I., reports the condition of his case, the younger child, as well after three years.

The older boy developed acute intestinal obstruction on November 30, 1921, nine months after the first operation. Laparotomy revealed a greatly distended colon from the ileocæcal valve to a point in the transverse colon which had become fixed in the vicinity of the original tear in the diaphragm. Cæcostomy was done and no effort was made to reduce the obstruction. X-ray examination then demonstrated an obstruction in the transverse colon. He left the hospital December 11, at which time his bowel movements had become normal. Five weeks later he was readmitted for incomplete intestinal obstruction, the cæcostomy acting intermittently as a safety valve. The X-ray examination again showed the barium column intercepted in the transverse colon at a point on the level of the diaphragm. On January 27, 1922, the left diaphragm was again exposed by the transthoracic approach. There was about eight ounces of fluid encapsulated between the base of the lung and the diaphragm. The lung was partially fixed at its base by bands of adhesions to the parietal pleura. It expanded well with inspiration. At the site of the original tear in the diaphragm was an opening about three cm. in diameter through which protruded a knuckle of large bowel, incarcerated by adhesions about the opening. The ring was cut and the bowel reduced without difficulty. It was then noted that the diaphragm, external to the opening, was comparatively thin. The opening was closed with figure-of-eight sutures of silk. Suspecting a trophic disturbance in the musculature of the diaphragm we tested its reaction to the faradic current through a secondary induction coil. On the median side of the cicatrix made by healing of the original tear the response was prompt and brisk, while to the outer side of the scar and over a wide area the reaction was sluggish until the rim of the diaphragm was approached. Here both latterly and posteriorly the contraction though not strong was evidently a nerve response. Anteriorly the response to electrical stimulation was scarcely perceptible. The chest was then closed with mass sutures of silkworm gut. The patient recovered and was discharged on February 2, 1922. The variation in irritability from a sharp, strong response on the median side of the scar to a very sluggish reaction on the outer side led us to assume that, at the time of the original tear, at least one branch of the phrenic nerve as it spread over the central portion of the diaphragm had been injured with nerve fibre and muscular waste resulting.

We had good reports concerning the patient's condition until November 30, 1922, ten months after the second operation, when he was admitted again because of abdominal pain and persistent vomiting. While coasting during the previous afternoon he had taken a " belly bumper " whereupon he was seized with cramps and distress in the abdomen. Upon examination there was definite evidence of peristalsis in the left chest as high as the angle of the scapula. The cæcostomy opening had entirely closed. Recurrence of the hernia through the diaphragm was therefore obvious. As a preliminary step the opening into the cæcum was reëstablished for immediate relief. Five days later, on December 5, the diaphragm was approached by laparotomy. The transverse colon was found to have passed through the diaphragm at the site of the original tear and held by adhesions about the opening. The patient was in good condition. We had become familiar with his measure of endurance, hence we felt that examination of the diaphragm similar to that made at a previous operation could be carried out with more accurate determinations. Therefore, we walled off the stomach, spleen and bowel, and drew the diaphragm well down into the operative field. An examination of this entire leaf was made as thoroughly as a reasonable time would permit. The edge of the left lobe of the liver had entered the hernial opening. Having become fixed in this position it was separated and withdrawn with some difficulty. This was sufficient to free the colon, a long loop of which was then drawn down through the opening into the abdominal cavity.

Examination of the diaphragm at the aperture revealed a thick cicatrix forming the inner edge of the ellipse with substantial body to the diaphragm adjacent, while the outer edge of the ellipse was thin and the middle portion of the diaphragm perceptibly meagre. This would appear to indicate that trophic disturbances had followed injury to terminal branches of the phrenic nerve and warrant the supposition that, under sudden violent increased pressure within the abdomen, rupture occurred by separation of the thin portion of the diaphragm from the margin of the old cicatrix. On this occasion the opening was closed by interrupted sutures of chromic catgut reinforced by a running stitch of silk. Electrical stimulation by the faradic current was applied to various portions of the diaphragm. An immediate sharp contraction showing normal nerve irritability was found along the course of the phrenic nerve, until it reached the cicatrix which ran almost transverse to the median branch. Further examination revealed not alone the perceptible thinning of the central portion of the diaphragm in this case but a sluggish response to the electric current over this area, indicative of degeneration in the terminal nerve fibres and motor end-plates in the muscle. Again as we approached the rim of the diaphragm contractility to stimuli was more pronounced but far less vigorous than over the unimpaired phrenic nerve. The abdomen was then closed and the patient made an uneventful recovery, leaving the hospital on the tenth day.

A review of the events in the above case provides material for a three-point discussion of the subject of recurring traumatic hernia of the diaphragm, dealing first with the cause of recurrence based upon a study of the position and nature of the tear in the diaphragm as well as alterations of its innervation and tonicity ; secondly, with choice in methods of approaching the diaphragm in order to repair the damage in similar cases, and third, with the technic to be employed in effecting a reduction of the displaced viscera and closing the rupture.

It is probable that the line of division in rupture of the diaphragm from external violence more often follows than crosses the nerve fibres and vessels, yet it is conceivable that instantaneous rupture from violence may not parallel the nerves in the direction of the median or lateral lumbo-costal arches, but more probably intersects their course and results in injury to the terminal

branches of the phrenic, sufficient to produce trophic changes in the musculature of the diaphragm with at least a moderate degree of eventration as a consequence. May this not be true of the median branch in particular? The findings in the above case would appear to justify this assumption, especially in the light of recurrence of hernia on each occasion after a nine months' period of apparent security and the persistence of a perceptible eventration of the left side of the diaphragm. Incidently, in this respect, traumatic hernia of the type here considered differs from congenital hernia, where, owing to a deficiency in the diaphragm itself the terminal branches of the phrenic nerve remain intact, but are merely diverted from their normal relation to each other.

In order to study the effects of disturbed innervation of the diaphragm and its application in the case reported above, Dr. Walter Cannon granted me the privilege of conducting a series of experiments with the coöperation of Dr. Alexander Forbes in the department of Physiology of the Harvard Medical School. The first experiment consisted in producing an opening 10 cm. long in the diaphragm of a dog under morphine and ether anæsthesia. The line selected was about 5 cm. to the left of the œsophageal opening and in an oblique antero-posterior direction. The result of this opening was a definite crippling of the diaphragm. Single make and break shocks produced a sharp reaction over the area of the median side of the artificial opening while the same test resulted in a less vigorous response over the nerve fibres on the outer side of the tear and a perceptible slowing down of the response of the musculature in the anterior and central part of the diaphragm. The second experiment was carried out upon the diaphragm of a cat, in which one year ago the upper root of the right phrenic nerve had been cut. By laparotomy both sides of the diaphragm were explored with stimulating electrodes. By using single break shocks the contractions in response to stimuli appeared to be normal or nearly so over the entire diaphragm. The abdomen was then closed and a dissection of the left side of the neck was made. Both roots of the left phrenic nerve were cut. The wound was closed. Ten days later the diaphragm was again exposed by laparotomy. Spontaneous contraction was seen in the right diaphragm, none in the left. Left side was visibly flabby as compared with the right and showed a tendency to rise when the right diaphragm contracted, a phenomenon which no doubt would be greatly increased with the abdomen closed. At first, exploration with the stimulating electrodes by using single make and break shocks seemed to show a brisk response in the central part of the right leaf and only small twitches in the same part of the left. Later the central part of the left side showed fairly good contraction, but nowhere comparable to the response obtained on the right diaphragm. In the ventral area, there was much less contraction on the left side than on the right. About the rim of the diaphragm there was good contractions on both sides.

The observations indicate a distinct nerve effect in the central part of the left side, but much less vigorous than in the corresponding part of the right

diaphragm and an unimpaired nerve response about the rim of the diaphragm on both sides.

The entire diaphragm was then excised. Stimulation was applied to the right central portion whereupon the whole right diaphragm responded, whereas the response on the left side was scarcely perceptible. The whole diaphragm was put in Zenker solution and sent to Dr. Stanley Cobb in the Department of Neuropathology at the Harvard Medical School. Stained sections from the right leaf showed normal structural conditions, while in the left diaphragm, from which the phrenic nerve had been severed for ten days, evidence of active changes was present in the form of early connective tissue proliferation. The nuclei of the connective-tissue cells were larger, more numerous and less deeply stained. The muscle striation had not disappeared, but there was evidence of this alteration in its incipiency. The silver stain used to determine the condition of the motor end plates failed us because we had preserved the tissue in Zenker's solution instead of formalin.

Nevertheless, the evidence thus far accumulated has served the purpose of demonstrating trophic changes in the diaphragm following nerve trauma similar to that occurring in other muscle structures following injury to nerve supply.

As a result of this change we have seen a loss in tonicity of the muscle body of the diaphragm, with a moderate degree of eventration and a probable susceptibility to recurrence of hernia after sudden increase of pressure within the abdomen.

Innervation of the Diaphragm.—In order to understand the alterations possible in the musculature and function of the diaphragm from injury to its nerve supply by trauma, it is necessary to know the source and distribution of the nerves which enter this important partition. By far the most important nerve to the diaphragm is the phrenic which has its origin from the fourth cervical nerve, reinforced by small roots from the third and fifth. In a dissection of these nerve roots in the cat we found only two cervical roots. Neuhöfer (Neuhöfer, P.: Mitteilunger Ans Den grenzgebieten Der Medizin und Chirurgie, 35, 1922, p. 1) has demonstrated that to these nerves are attached the sympathetic fibres from the lower ganglia of the neck. Below the phrenic nerve pursues an antero-lateral course and pierces the diaphragm at the junction between the musculature and the central tendon. Under cover of the peritoneum it splits into three branches a lateral, anterior, and posterior. The rim of the diaphragm is supplied by the lower intercostal nerves. Meckel (Meckel, J. F.: "Handbuch der Meuschlichen Anatomie," Berlin, 1817) described these motor nerves in 1817 and Joseph Swan (Swan, Joseph: A Demonstration of the Nerves of the Human Body, London, 1830, p. 29) wrote at length on this innervation in 1830. Hence this motor intercostal innervation is pretty well established. Ramström (Ramström: Mittlg. a. d. Grenzgeb. der Med. u. Chir., 15, 1906, p. 642) goes further and says, "the intercostals send not only motor but sensory nerves to the rim of the diaphragm. The serous covering of the diaphragm in its central part is supplied

by the sympathetic and phrenic, while the five lowest intercostal nerves supply its peripheral part." Felix (Deutsche Zeitschrift fur Chirurgie, 1922, p. 171) in his experimental work demonstrated very fine branches from the phrenic nerve going into the peritoneum as well as into the pleura of the diaphragm. These serous endings of the phrenic nerve lie with very few exceptions in the central part of the diaphragm and again in the lumbar part of this region. Felix also demonstrated that almost all the phrenic branches which have sensory endings in the serous covering of the diaphragm are associated with the sympathetic. He believes it possible that the sympathetic controls some of the musculature of the diaphragm. Furthermore he points out the well-recognized clinical fact that irritation of phrenic nerve endings produces pain in the region of the shoulder as observed in subdiaphragmatic abscess. In addition, Luschka (Luschka: Nervus Phrenicus, Tübingen, 1853) has shown that irritation of the intercosal nerves to the diaphragm produces pain in the epigastrium. Under these circumstances there must be a zone in the diaphragm which when irritated will produce pain that is local and pain that is referred also to the shoulder. Gerhardt (Die Pleuraerkrankungen Stuttgart, 1892) found in four cases of diaphragmatic pleuritis abdominal pain as well as shoulder pain. He referred the former solely to the intercostal nerves.

Mechanism of Rupture.—With these anatomical facts before us the events associated with rupture of the diaphragm are more easily understood, though curious and engaging. Immediately following a rent in the diaphragm there is a tendency for the pressure in the pleural and peritoneal cavities to equalize. The normal negative pressure in the thorax soon equalizes with the positive pressure of the abdominal cavity. Upon inspiration, contraction of the normal side of the diaphragm increases the positive pressure within the abdominal cavity, thereby pushing the swinging abdominal visceral into the opening through the ruptured leaf of the diaphragm. Here the viscera are helped along in the upward direction by suction from the expanding thorax above. Thus a double force immediately comes into play, resulting in a transposition of the abdominal viscera. As much passes through the aperture from below as the size of its lumen permits. The lung on the affected side expands in proportion to the free space in the thoracic cage. For example, at the first operation we found the left chest cavity filled with coils of intestine and the lung on the same side in a state of complete collapse. During the second operation, the aperture in the diaphragm was small and completely closed by a knuckle of intestine. Here the lung was expanding to the limit of space allowed above the small amount of encysted fluid over the diaphragm. The motion of the crippled diaphragm was observed to be limited always. Its relative position was high when only an angle of gut closed the opening, perhaps normal or readily accessible from below when a loop of the colon had passed into the thorax, and completely fallen when a large mass of obstructed and dilated gut occupied the entire thoracic cage. Under the latter circumstances the injured leaf of the diaphragm was forced into a state similar

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to that of the abdominal wall in the presence of intestinal obstruction. There-fore, it is obvious that many factors come into play, making the clinical picture of traumatic hernia of the diaphragm varied and of compelling interest.

Methods of Approach.—The different methods employed in approaching the diaphragm in our cases afforded an opportunity for comparison under conditions that in many respects were similar. We learned at the first operation that reduction of a considerable length of incarcerated gut through the diaphragmatic opening by means of thoracotomy would be exceedingly difficult, if not impossible, unless the diaphragm was elevated to a considerable height by a finger hooked under the margin of the ring, thus creating a vacuum in the abdominal cavity; that adhesions within the thoracic cage are more easily dealt with by means of an intercostal approach; and that laparotomy in the absence of adhesions above the diaphragm is an equally good approach especially if the patient is a child. It is a less disquieting means of access because it is a more familiar operation to the average surgeon. The choice of method in approaching the diaphragm is more often an individual problem. The surgeon will do wisely to select the method which best fits into his own scheme of things.

The method of closing the opening in the diaphragm has varied consider-ably in the hands of different surgeons, owing to individual preferences and to the great variety in the types of hernia.

Scudder denuded the edges of the aperture in the diaphragm and used catgut and fine silk for closure. (Transactions of American Surgical Asso., vol. xxx, p. 428).

Mathews (Trans. American Surgical Association, vol. xxxviii, p. 620) employed mattress sutures of chromic gut to close the orifice in the dia-phragm and anchored the stomach to the suture line of the abdominal incision.

Arthur D. Bevan (Archives of Surgery, vol. i, no. 1, p. 23) closed the opening in the diaphragm with interrupted sutures of Pagenstecher linen. In two cases where a hernial sac existed he closed the opening of the invagi-nated sac with catgut, but in each case exercised the precaution of anchoring the stomach to the diaphragm or to the parietal peritoneum.

James F. Mitchell (Trans. American Surgical Association, vol. xxxviii, p. 623) closed the opening with catgut. His suture line was so near the chest wall that he anchored it there with mattress sutures.

In the first operation we closed the tear in the diaphragm with a running suture of catgut reinforced by three sutures of the same material. At the second operation we enlarged the opening, denuded the edges, then closed with catgut and interrupted sutures of silk. In the last instance we prepared the aperture in the same manner and closed the opening with interrupted sutures of silk reinforced by a running suture of chromic catgut.

It is now about six months since the last operation and the child is once more apparently well.

SUMMARY

1. Recurrence of hernia of the diaphragm after many months is a liability irrespective of the method or suture material employed in repair of the hernia orifice.

2. Deficiency in the musculature of the diaphragm exists as a natural sequence of prolonged limitation of function or of trauma to terminal branches of the phrenic nerve, or of both of these conditions.

3. The method of approach in dealing with hernia of the diaphragm may be selected to best advantage after determining the direction of greater accessibility, and conditions to be met above and below the diaphragm.

4. Early operation and the avoidance of such activities as produce unusual increase of intra-abdominal pressure is the only safeguard against recurrence.

A METHOD OF REPAIRING INGUINAL HERNIA WITH LIVING SUTURES TAKEN FROM THE EXTERNAL OBLIQUE TENDON

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It will probably be generally agreed that recurrences after operation for the radical cure of inguinal hernia, are much more frequent than a casual reference to statistics would lead one to believe. Indeed, recurrence after operation for direct inguinal hernia in patients over fifty years of age is so high that some operators consider operation inadvisable in this class of patients unless there are special indications.

Fig. 1.—Showing outline of suture to be taken from the tendon of the external oblique. The superficial parts are left out for the sake of clearness.

Recent researches in the use of living sutures, especially that of Gallie and Le Mesurier, have opened up a new field in the repair of hernial openings. His experimental work has shown that "sutures of fascia lata when placed in such a position that they receive an adequate supply of lymph, continue to live practically unchanged." When drawn through "a tight needle hole they become folded into rounded cords, and in the course of two or three weeks, become surrounded with a vascular areolar film which sends septa of similar tissue into the depths of the cord in the spaces between the folds. A cross-section of the suture at this time and later has the appearance of normal tendon."

It occurred to the author while operating for inguinal hernia that use might be made of a suture from the tendon of the external oblique to repair the defect. After experimenting on the fresh cadaver the method here described was worked out. I have performed the operation four times on the living for indirect inguinal hernia and have been impressed with the satisfactory closure the method gives. I believe it insures that the internal oblique will not become detached from Poupart's ligament, which operations for recurrent hernia have so frequently shown to have occurred.

Technic.—A five-inch incision is made in the usual site terminating slightly below the pubic spine. The external ring and the tendon of the external oblique up to its origin from the fleshy belly of the muscle is cleared. One blade of a pair of blunt scissors enters the external ring near its inner pillar, and with the scissors following the direction of the fibres the tendon is slit up to its origin from the muscle. A second incision one-quarter inch internal to the first is made through the tendon with

FIG. 2.—Showing the beginning of the first stitch; the needle passing through the conjoined tendon, close to the pubis.

a scalpel, at a point about an inch above the pubic bone. The blade of the scissors is inserted into this incision and carried parallel to the first incision up to the muscular fibres where the strip of tendon is severed from its muscular attachment. In completing the freeing of the strip of tendon below, the incision at a point about half an inch from the pubic bone bends inward, thus giving the strip of tendon to be used as a suture, a wide attachment to the bone (Fig. 1).

The free end of the suture thus obtained is threaded on a curved needle with a large eye, and the end secured against slipping out with a ligature of fine catgut. The needle is then passed through the conjoined tendon close to the pubis (Fig. 2). This results in strain being applied in the normal direction of tendon fibres, and should ensure that the suture will not be pulled from its

FIG. 3.—Showing the suturing of the internal oblique to Poupart's ligament completed. The centre stitch is locked by passing the needle through the suture and then through the loop.

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bony attachment. The needle now picks up the reflected portion of Poupart's ligament and the periosteum covering the pubic bone close to the spine. The internal oblique is drawn down to Poupart's ligament with additional stitches as shown in the illustration (Fig. 3), the end being secured by drawing the suture through itself, splitting the ends and tying them across in a triple knot after the method of Gallie. After the knot is tied, a needle threaded with No. o chromic catgut is p a s s e d through the knot and tied. Additional security against the knot slipping can be obtained by passing the needle beneath the suture or through the a d j a c e n t portion of Poupart's ligament and tying down the ends. The edges of the external oblique are now sutured external to the cord in the usual way.

FIG. 4.—Showing method of using an extra suture taken from tendon of the internal oblique to close the upper end of the opening.

In the cases in which I have used the method this single suture taken from the external oblique tendon has been long enough to effectively close the defect. However, if an additional suture to close the upper end be required it can be obtained, by dissecting up the external oblique tendon from the underlying tendon of the internal oblique as far as the median line. A slip of the internal oblique tendon is then cut out, leaving its muscular attachment undisturbed. This suture is threaded on a needle as before, the needle is passed through the cut edges of the internal oblique tendon, and then through the loop, thus forming a knot which prevents the suture pulling away from the muscular attachment. The needle is then passed through Poupart's ligament and up through the internal oblique and the end secured as before (Fig. 4). The gap in the
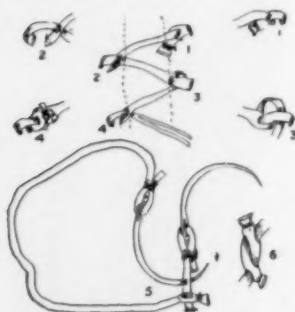

FIG. 5.—Diagram showing method of inserting fascial suture. (1) Anchoring suture at its commencement by looping it through itself. (2) Fixation of suture at each loop by passing it through itself. (3) Fixation by transfixion and knot. (4) Ending of suture by passing through itself, splitting and tying end in knot. (5) Method of joining new suture to one that has been inserted. (6) Join completed. (Gallie and Le Mesurier).

tendon of the internal oblique from which the suture has been taken is closed with No. 1 chromic catgut.

Should the operator choose to reinforce the repair with additional catgut sutures I see no reason why he should not do so. In the cases in which I have used the method they did not seem necessary and were not used. No difficulty has been experienced in uniting the edges of external oblique tendon external to the cord without undue tension.

I have tried a variation of this method in the fresh cadaver, in which a second suture was taken from the opposite edge of the external oblique tendon; the edges of the external oblique in this case being united behind the cord. I have not used this method on the living.

The operation is simple, does not require a second incision to obtain the suture and, in the author's opinion, should lessen considerably the risk of recurrence.

CYSTS OF THE WOLFFIAN BODY

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The extreme rarity of occurrence of cysts of the Wolffian body (meso-nephros) and the paucity of reports in the literature warrants the consideration of such cases when they are encountered. For a thorough knowledge of these cysts as regards their character and location, one must bear in mind the retroperitoneal development of the Wolffian body in the lumbar region; its complex metamorphosis, the remarkable migration of its component parts and their ultimate fate, the atrophic changes which they undergo and, lastly, the vestigial remnants as they exist after complete development has occurred. The surgeon is not fully efficient who does not bear in mind the pathological potentialities of the Wolffian body in the exploration of the abdomen. These facts, together with the confusion extant in the literature, the failure of text-books to consider the Wolffian body in differential diagnosis, renders impor-tant the consideration anew. The subject was brought to our attention by the case reported below.

The present tendency is to credit nearly all cystic retroperitoneal tumors as having their origin from fœtal renal elements, unless they are definitely proven to be associated with other organs. Lobstein, in 1829, and later Witzel (Bauer), were the first to describe retroperitoneal tumors; they did not differentiate between the cystic and solid tumors and gave but little infor-mation as to origin. There appears to be some confusion as to who first pointed out the relationship between these cystic tumors and the Wolffian body. Kroenig credits Roth as having been the first to point out their true etiology in 1881 (Maury), while Bauer says that Przewoski in 1886 was the initial investigator to call attention to their connection with the Wolffian and Mullerian bodies. These findings were later confirmed by Obalinsky, Niosi and von Hippel. Since then but few cases are to be found in the literature which show any true morphological relationship. All retroperitoneal serous cysts, retroperitoneal cystadenomata, etc., unless definitely associated with an organ, are put in the same group by most authors.

Case.*—L. D., male, white, age twenty-seven months, was seen because of a swelling in the lower left flank. The family history was negative except that the father had been treated for lues. The past history showed the child to have had a normal feeding and developmental course. There was no history of any disease.

* This case is reported by courtesy of Dr. Richard F. Tomlinson, San Francisco.

The present illness began about six months prior to operation when the mother noticed a small swelling in the region of the left flank. This gradually increased in size until at the time of operation it was the size of a small orange. The mother states that at no time were there any gastro-intestinal or urinary signs and symptoms. No hæmaturia nor other urinary signs were noticed. The child appeared happy at all times and never seemed in distress. There was no loss of weight nor signs of emaciation, except that the mother thought the child to be a little pallid.

The physical examination showed the child to be well developed and nourished. The abdomen was flat, soft and tympanitic throughout. No areas of tenderness were made out. Palpation of the left abdomen easily revealed a painless tumor about the size of an orange which was freely movable, ballotable and seemed semifluctuant in consistency. The left kidney was not felt. The remainder of the examination was negative.

Röntgen-ray examination of the abdomen showed some vaguely outlined mass to the left of the spine, opposite the third and fourth lumbar vertebræ. The urine examination was negative.

The case was seen in consultation with an urologist and it was decided that the tumor mass was in no way related to the urinary tract. A diagnosis of chylous or dermoid cyst was made and operation advised.

Operation was performed under gas and ether anæsthesia. A midline incision 12 cm. in length was made. The peritoneal contents were found to be normal. The tumor mass was easily felt and found to be situated retroperitoneally just caudad and somewhat anterior to the left kidney. No relationship to the left kidney could be made out. The posterior peritoneum was then penetrated and the tumor found to be a cyst about 6 cm. in diameter. No pedicle was found but the attachment was by means of a broad base retroperitoneally. Adjoining this cyst was found a smaller cyst about 1 to 2 cm. in diameter. The cystic mass was easily shelled out and closure made in the usual manner. The convalescence was uneventful, the child leaving the hospital on the eighth day post-operatively.

FIG. 1.—Photograph showing external aspect of Wolffian body cyst. The cavities of the larger and smaller cysts communicate. The larger cyst measures 6½ cm. in diameter, the smaller 2 cm.

Pathological Report. Gross.—Specimen (Fig. 1) consists of a tough, thin-walled sac in two parts which communicate with each other. The larger measuring approximately 6½ cm. and the smaller 2 cm. The thickness of the wall varies considerably, but for the most part is of paper thickness and at no point is more than 5 mm. The lining of the two parts is smooth and shiny, the contents a thin straw-colored fluid.

Microscopic.—Sections of the wall at the thickest point to show the lining of both cysts, reveals a rather dense fibrous wall and a very dense hyalinized connective-tissue

lining. Throughout the connective tissue of the wall are a multitude of small or large alveolar structures lined by a cuboidal or low columnar epithelium, numerous structures resembling quite closely the glomeruli of the kidney and a multitude of large, quite thick-walled vessels. (Figs. 2, 3, 4.) An occasional large microscopic cavity which probably represents a small cyst, shows an epithelial lining varying from a single to several layers and taking mostly the low cuboidal form. The structures described in the wall represent primitive glomeruli of the Wolffian body and primitive tubules. The picture is typical of that of a retroperitoneal cyst arising from the anlage of the Wolffian body.

FIG. 2.—Microphotograph (low power) showing thickest portion of cyst wall. A dense hyalinized layer of connective tissue lines the cyst cavity. Note primitive glomerular and tubular structures scattered throughout cyst wall.

Diagnosis: Retroperitoneal cyst of Wolffian body origin.

Pathogenesis.—Intra-abdominal cysts of various types form the subject of a voluminous literature, chiefly European. They are reported as having origin in nearly every structure within the limits of the abdomen, intra-, extra- or retro-peritoneal. Thus there have been described pancreatic, ovarian, parovarian, renal, perirenal, pararenal, mesenteric, peritoneal, omental, omphalo-mesenteric, retroperitoneal, Wolffian body (mesonephric), lymphatic, dermoid, hepatic, ecchinococcus, chylous, serous, uni- and multilocular cysts, benign and malignant cystadenomata, as well as cysts arising from remnants of the Mullerian ducts.

Due to the remoteness in point of time and the obscurity which veils the origin of many of these cysts, great confusion has arisen as to their true nature and pathogenesis. It has, therefore, been impossible to review the literature with the hope of selecting those cysts of definite mesonephric origin. This difficulty arises not alone from the variety of locations these cysts may occupy, but from their variegated histo-pathological structure as well. A cyst may be situated in the fused layers of the mesocolon and delude the surgeon into believing them intraperitoneal; or may so closely approximate the gut as to suggest an enteric origin. Moreover, the histological structure may present a variety of pictures quite contrary to that of the normal mesonephric elements.

There exists one definite criterion which denotes a given cyst as being of mesonephric origin and that is the presence of primitive glomeruli or

renal tubules in the cyst wall (the cyst, of course, being independent of the kidney). This type of cyst is of the greatest rarity, only four cases having been reported on the American continent (Maury). The literature, however, abounds with reports of cysts which present none of these structures and yet are considered as being of Wolffian origin, either on mere supposition or reasoning by a process of elimination. It is highly probable, and more evidence is gradually being collected to support the view, that a great variety of cystic and solid neoplasms of the retroperitoneal space in relation to the adrenal, the kidney, the broad ligament, spermatic cord, epididymis and possibly the testicle, have their origin in Wolffian body remnants. In the last analysis the etiology of testicular tumors remains unknown and the theory is tenable that such tumors may arise from remnants of the Wolffian body. Bland-Sutton has suggested the paradidymis as the origin of certain testicular neoplasms. In a previous report † the literature on dermoid cysts of the spermatic cord has been reviewed
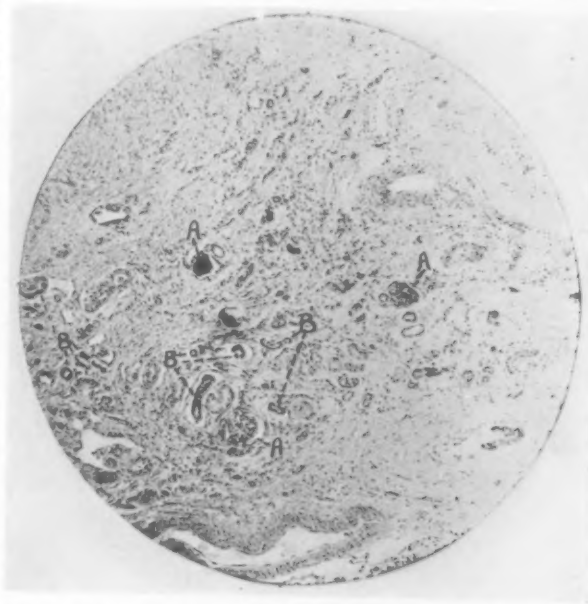

Fig. 3.—Microphotograph (low power) of area from cyst wall showing well formed glomeruli A, and tubules B, resembling closely the adult structure.

and their origin considered. Staehlin emphasizes the fact that the pronephric portion of the Wolffian duct arises in part from primitive ectoderm and suggests this as an explanation of various dermoids seen within the abdomen and along the spermatic cord. In the complex development of the urogenital tract there undoubtedly exists abundant opportunities for maldevelopments, while the numerous fœtal remnants left over in the process of development afford an attractive explanation for these cysts. Definite evidence in support of this hypothesis is furnished by the fact that mesonephric cysts are of much greater frequency in the female sex, a fact explained by Maury as being due to the relatively greater amount of Wolffian body remnants existing in the female as compared to the male. The latter utilizes most of his primitive urinary excretory apparatus in the formation of the vas deferens and epididymis, whereas in the female the major portion of the Wolffian body remains vestigial.

† Hinman and Gibson: Tumors of the Spermatic Cord, Epididymis, etc. Arch. Surg., January, 1924, p. 100.

It was stated above that the mesonephros definitely gives rise to cyst formation, as shown by the finding of retroperitoneal cysts with primitive glomeruli and tubules in their walls. These constitute an extremely small group and to these must be added a relatively larger group of retroperitoneal cysts which do not exhibit such structures but exhibit a more or less fibrous wall with an inner epithelial lining, varying from a simple single layer to cyst adenomatous structures. Reasoning by a process of exclusion, Jacquot and Fairise, having made a careful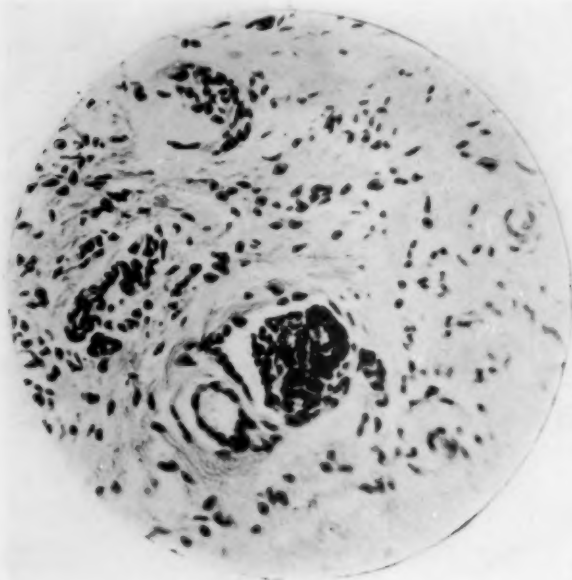 study, have shown that these also must be considered as being derived of the Wolffian body. Maury has stated that one is forced to the conclusion that all retroperitoneal cysts not arising from retroperitoneal organs are genetically Wolffian. Jacquot and Fairise h a v e reported such a case in an eighteen-year-old female, a large cyst containing 4 to 5 litres of fluid, situated between the layers of the descending mesocolon. They supply a very comprehensive bibliography and review the literature, collecting with their own,

FIG. 4.—Microphotograph (high power) of area from cyst wall showing more or less differentiated glomeruli in a matrix of connective tissue.

fourteen cases which they consider definite Wolffian cysts.

Clinical.—Eliminating the solid retroperitoneal tumors, there remains but a very small group of cystic tumors. If we further eliminate such cysts whose structure morphologically give us no clue as to their origin and confine ourselves to such as do show definite embryologic structures in their walls, it is at once apparent that such tumors are exceedingly rare. Due to the confusion in the literature and the entire absence of clinical statistics relative to incidence, no definite statements can be made. Suffice it to say, cystic tumors similar to the one reported, are most rare.

As far as we can determine they occur almost always in the female. Nor are they confined to any particular period of life as indicated by Maury's case and ours. The former occurred in a woman of twenty-eight years, while the latter was found in a male child of twenty-seven months. The youngest case in the literature is one of ten months, reported by Albarran, while Kast

has reported one in a woman of sixty-five years. For the most part it can be said that they occur chiefly during adult life.

The symptomatology is practically limited to physical signs, especially while the tumor is still small. Due to the diversified locations, the symptomatology may be variable. Their beginning is slow and progressive and may therefore pass unnoticed at first. The occurrence of a blow or fall may quite accidentally call attention to such an abdominal tumor. In children, asymmetrical prominence of the abdomen may cause the parents to examine it. Only when a large size has been attained do we begin to get subjective symptoms. A sensation of fulness with some dull painful radiations in the lumbar region may attract attention to the tumor. Attacks of renal colic have been noted in some cases probably due to ureteral compression. As the tumor increases in size the appearance of pressure signs may become apparent. Again, the location of the tumor is the main f a c t o r ; tumors in the renal or perirenal position may give a neuralgia of the

FIG. 5.—Microphotograph (low power) of area from kidney of 20 mm. human embryo showing resemblance to structure in wall of Wolffian cyst.

twelfth dorsal nerve; then again the situation may be in such relation to the ureter as to produce symptoms of hydronephrosis. Compression of the left renal or spermatic vein may lead to varicocele formation. Large tumors situated in the pelvis may lead to œdema and varices of the lower limbs. Rarely do ascites, compression of the portal vein or intestinal obstruction occur. If the latter is present the symptoms will be those of a chronic obstruction. Attention has also been called to the fact that urinary frequency may be caused by pressure on the bladder. From the signs noted, it is apparent that exclusive of the size of the tumor itself, the subjective and objective signs and symptoms are essentially those of pressure. That they may attain a huge size is noted by the fact that some cases have reached the capacity of ten litres.

The diagnosis is essentially one of exclusion. The making of an exact diagnosis is therefore a difficult one. Cases as a rule are only correctly diagnosed at operation or later by the pathologist. If an urological investi-
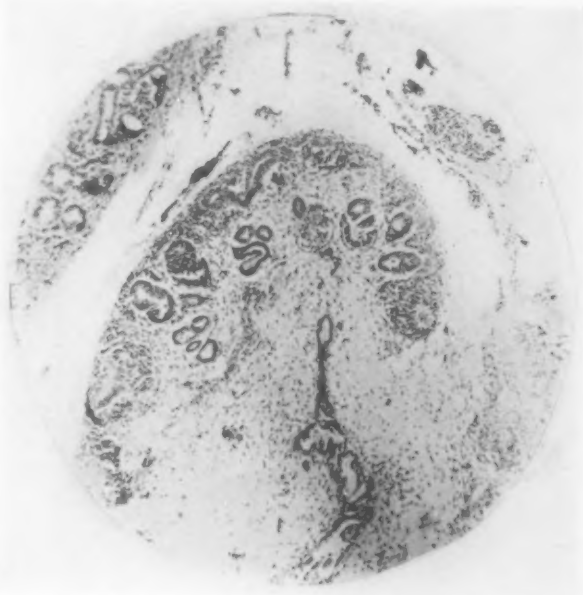
gation excludes the tumor from the urinary tract the differential diagnosis still rests on a large number of possibilities such as movable spleen, Riedel's lobe of the liver, adrenal tumor, solitary cyst of the kidney, benign and malignant peri- and para-renal tumors of a solid nature, lipoma, ovarian cyst, pancreatic cyst, lymphatic cyst, enteric cyst, omental cyst, etc. The history of a long duration is a factor against malignancy, yet certain of these cysts of an adenomatous type may become malignant, resembling ovarian cysts in this respect. These cysts when small are generally freely movable. Likewise they are generally smooth in outline, a point against solid malignant tumors. In view of the extreme difficulty of clinical diagnosis, the surgeon can, as a rule, only keep in mind the possibilities. If on surgical exploration a cystic structure is found independent of the postperitoneal organs, it may be considered of Wolffian origin. The contents of the cyst vary with the type, probably depending on the portion of the

Fig. 6.—Microphotograph (high power) of area from kidney of 20 mm. human embryo. Note the close resemblance to the primitive renal structures in the wall of the Wolffian cyst.

mesonephros from which it originated. The fluid may be thin, serous, chocolate-brown or pseudomucinous in type. Whether those cysts whose walls show tubules and glomeruli contain urinary elements has not been stated.

Treatment consists in early and complete removal, not only because of the inherent tendency to continued increase in size, but also because there is a tendency to malignant degeneration in certain types. The prognosis is an excellent one, excepting in those cases of malignant change and huge size.

SUMMARY

1. Cysts of the Wolffian body are of such rarity as to warrant reporting.

2. The case reported is a true Wolffian body cyst, as evidenced by the finding of primitive renal structures in its wall.

3. Pathologically great confusion exists in the literature, as shown by the large variety of cysts which have been attributed to Wolffian origin. In the absence of any definite relationship to retroperitoneal organs, the presence of all such cysts in that region or between the layers of the mesocolon are probably of Wolffian origin, even though recognizable primitive renal elements are not to be found in their walls.

4. Wolffian body cysts have generally been found in the female. This is probably due to the fact that a greater portion of the Wolffian body and duct

become vestigial remnants in the female, whereas in the male it is almost entirely utilized in the formation of the genital tract.

5. Cysts of the Wolffian body may occur at all ages, but especially during adult life.

6. The symptomatology consists chiefly of secondary compression phenomena, varying with the size and location of the tumor. These cysts may grow to a volume of ten litres.

7. Diagnosis is chiefly one of exclusion and is usually made at operation or on later pathological study.

8. Treatment consists of early and complete removal because of the tendency toward malignant degeneration in certain types.

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STRICTURE OF THE FEMALE URETHRA

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History.—Stricture of the female urethra was first described by Lisfranc [1] in the year 1824. After which very little appears in the literature until the work of Civiale in 1850. [2] This author carried out extensive urological researches, and was the first to call attention to the response of the sympathetic nervous system to urethral lesions, an important factor in this disease. In 1875, Newman recognized the importance of stricture of the female urethra and advocated its treatment by electrolysis. [3] Fissaux, in his essay of 1879, presents an interesting review. [4]

Van de Warker, [5] in his first paper in 1887 and later in 1890, [6] states that all the great writers on gynæcological and urinary conditions seem to treat with silence a matter of great import, namely that of stricture of the female urethra. His articles are forceful and to the point.

Skene, [7] in 1887, calls our attention to the fact that stricture while not common, occurs more frequently than we think, and often enough to require careful consideration. In the same year the question was taken up in a symposium, by the London Obstetrical Society, and a number of interesting cases reported. Otis, [8] in 1892, says, stricture of the urethra in women may occur in sufficient extent to cause reflex troubles as varied and severe as that occasioned by urethral stricture in men, and this quite independent of any trauma. He also states that where urinary conditions do not respond well to treatment the patient's urethra should be explored by the urethrameter or the bulbous sound. Otis was well in advance of his period and his bulbous sound principle considerably antedating the excellent work of Hunner and others, with the olivary tip catheters and wax points.

Abdominal surgery and its wonderful development, both gynæcological as well as urological, with its splendid technics and excellent results, has apparently been responsible for our overlooking comparatively small things like the female urethra. Our attention has been drawn strongly toward the more spectacular things related to the uterus and adnexa or the kidneys and ureters. Great oaks from little acorns grow and the female urethra is responsible for more widespread suffering than many of us have realized. The remarks of Hunner [9] to the effect that from recent observations he felt urologists were inclined to overlook urological conditions in the female, are certainly most appropriate when applied to the urethra. This, however, need give little solace to the gynæcologist as we all seem to have strolled in the same paths.

In a review of some of the late works on gynæcology, notably such representative books as that of Graves,[10] stricture of the urethra is dismissed in a few lines. Text-books on urology in women, of such encyclopædic scope as Kelly and Burnam,[11] furnish us with little of note, while standard works on urology as Keyes[12] mention it but briefly. In the larger work on modern urology edited by Cabot it is given a little more than usual consideration by Osgood.[13]

I believe we can summarize the history by saying that aside from the pioneer work of Van de Warker and Otis, there seems to have been comparatively little research in this highly important field until the observations of Stevens and Hunner during the past few years.

Incidence.—In an examination of 3000 gynæcological and urological records in this country and Europe, I found four cases diagnosed as stricture of the female urethra. These were all cases that were readily diagnosed, one a carcinoma, one following an obstetric tear into the urethra and three cases of marked gonorrhœal infiltration.

Wynne[14] quotes Winckel as having found 3 cases in 3000 gynæcological records. In his early essays[15] and in his last text-books,[16] Winckel also states it is rare. Meisel,[17] of Budapest, found 378 strictures in the male to one in female. Pasteur[18] collected 112 cases from the literature. Fischer[19] records 4 cases in 4000 records. Herman,[20] in England, noted 69 cases. The similarity in the percentage reports in the larger series are very striking.

Osgood tells us that the urethra in the female is analogous to the membranous urethra in the male. Stricture of this portion of the urethra in the male (because of its squamous epithelium which offers resistance to infection and its absence of glandular structures in a continuation of the mucosa) is rare. This Osgood further tells us is the condition existing in the female urethra as well. Reasoning in this manner seems very sound both from an anatomical and theoretical standpoint.

Hunner,[21] in his contributions to the literature, speaks of narrowing of the urethra associated with ureteral lesions. In some of his case records of ureteral cases, notes of urethral infiltrations also occur. He is quoted by Stevens as finding 60 per cent. of those suffering with ureteral stricture to have urethral stenosis in addition. Bugbee[22] states that he is surprised to find the extent to which stricture of the urethra exists in women.

Stevens,[23] of San Francisco, believes that stricture of the female urethra is an important condition that has only recently been accorded real recognition, being constantly overlooked by both gynæcologist and the urologist. In 169 urological cases in women he found urethral stricture in 90. This series is certainly worthy of our attention, as it emphasizes quite strikingly the frequency of the disease.

In an examination of 180 women presenting urological symptoms I have found urethral stricture in varying degree in 35, and I believe we are justified in calling this common. Stevens makes a good point when he states that strictures of the female urethra are overlooked because we too readily accept the oft-stated opinion that they are rare.[24] If there is one point on which most writers heretofore seem to agree it is that stricture of the female urethra is rare.

Etiology.—The causes of stricture of the female urethra given in the literature are many and varied. It will suffice to consider the more common factors.

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Most of the older writers seem to cling rather strongly to the traumas incident to childbirth as most important, Winckel notably placing it above all. Many cases of trauma other than obstetrical are noted by mid-European writers, as Stoeckel [25] and Pleschner.[26] Stricture following catheter injuries are noted by Teleky,[27] Hoehne [28] and others. Tumors as direct causes are noted by Goldschmidt,[29] Thompson,[30] Kleinwachter,[31] Teleky and Heinrichsdorf,[32] although little detail is given as to the pathology of these growths. Caruncle and papilloma are, however, mentioned. Herman [33] speaks of lupus, Duncan [34] of luetic ulceration, Gallabin [35] syphilis, Routh [36] of a stricture following parametritis. Goldschmidt of syphilis, Duncan of cirrhosis. Senile prolapse, vesico vaginal fistula and congenital narrowing are also noted by European writers.

Skene always practical, says the causes are usually the same in women as in men, or in other words, gonorrhœa in the vast majority of cases. Graves notes gonorrhœa and childbirth as a cause; Kelly and Burnam and also Osgood mention gonorrhœa, syphilis and tuberculosis as factors. Hunner believes in focal infections, but Stevens thinks they play no great part. I cannot see why, if focal infections are recognized as playing a part in ureteral strictures, they should not be held responsible for urethral lesions, particularly when one considers the tissue structure of the two organs. Hunner seems to have proved his point I believe and some of Skene's cases also suggest focal infection.

In my own series of cases, the etiology was as follows: Gonorrhœa 24, chancroid 2, syphilis 1, childbirth trauma 1, keloid 1, possible focal infection 5.

This list shows a great preponderance of gonorrhœal lesions and in my own mind I am fully convinced that it is the main factor in stricture of the female urethra. It is also possible that some of these focal infections so noted were gonorrhœal, although this infection was vigorously denied by all.

Pathology.—Our knowledge of the pathology of the female urethra and particularly as applied to stricture is not extensive. In view of my findings, gonorrhœa plays an important part in the pathology and a gonorrhœal process is usually the first stage of the disease leading to stricture. A stricture may be defined to be an organic change in the wall of the canal with a narrowing of its calibre and a diminution of its normal dilatability. The stricture formation usually begins on the floor of the urethra and at the point where the gonorrhœal process has reached its greatest intensity. From what we can see with the cysto-urethroscope and note with the bulbous bougie, there are both soft and dense strictures. In fact, I believe we can go a little farther and apply there a classification similar to that of Oberlander's for infiltrations, namely soft strictures and hard strictures of the first, second and third degree.

In lesions following obstetric trauma, we have the pathology of the ordinary crushing type of injury. Ulcers and neoplasms, such as carcinoma, sarcoma, papilloma, etc., differ in no way from their general characteristics as noted in other parts of the body.

Symptoms.—A carefully taken history is most essential and everything in relation to the patient's previous condition must be clearly brought out. A history of venereal infection is often difficult to obtain, particularly in our better class of patients. The fact is, many may not know that they ever had it, as the ignorance of most people regarding venereal infections or sex matters is astounding. A history of whites or leucorrhœa should always be looked on with suspicion. Many patients who have had venereal infections may lead us astray in our examinations. Men, we know, frequently think they are deceiving us, even when we show them the gonococcus, women even more so.

Any history of childbirth injury should be noted, or an operation following the same, such as urethro-vaginal fistula. Obstetricians tell us injuries apparently mild sometimes produce these conditions. A history of malignant disease or tuberculosis is important. The infectious diseases, scarlet fever, typhoid and pneumonia, as possible factors, are well worthy of attention. Localized foci of suppuration should also be noted. Do not overlook the local use of cauterants or strongly astringent vaginal douches.

Gynæcologists tell us that the clinical history of such a case is not marked until the patient notes an increased difficulty in emptying the bladder, which difficulty may at times be extreme. One would naturally expect this to occur, but this is by no means always the case. In fact, in most cases frequency and dysuria are the symptoms most commonly complained of, and in several the symptoms more strongly suggested abdominal and renal lesions than they did urethral. Many cases present most remote symptoms, and if one is not careful, we may put them down as neurotics. The retention of urine by women for long periods is so common that they often seem to think it a natural condition. Far more do women complain of dribbling (really an incontinence or retention) than they do of obstructive symptoms. Slight obstruction, however, is often sufficient to produce a marked cystitis and urinary changes. Some writers tell us that symptoms of urethral stricture occur earlier in women than they do in men and this is possibly true.

The symptoms of importance in my series of cases were dysuria, urgency and frequency; signs of auto-intoxication were also common. In the advanced cases actual obstructive symptoms were present. The reporting of cases by Stanton, in which renal colic was associated with urethral stricture in the female, are valuable as they bring out the relationship of the urethra and the renal organs through the sympathetic nervous system. This is a syndrome which has been but little noted before, but of which many of our patients complain in a greater or less degree. In view of what we have learned from our cases, we must not look for the classical text-book symptoms in urethral stricture in women, as it is unusual to find them. If, however, we take a careful history and find any suggestive urinary symptoms, we are justified in making a urethral examination. In fact, we should do it as a routine in all our female urological cases, using for the purpose either the olive tip bougie or the bulbs.

When we are able to use a small urethroscope we find that it meets an obstruction, and on withdrawing it we find the scar. Meltzer says urethral infiltrations are commonly found on the floor where the glands are most numerous. Hard infiltrations not only can be seen, but at times cause quite a tug on the instrument. In hard infiltrations the mucosa looks pale and on withdrawing the instrument the canal seems to have lost its elasticity and does not readily collapse. The urethroscope should always be used when possible to do so. The Röntgen-ray as a diagnostic medium has not been satisfactory in this class of cases.

What is a Stricture?—Text-books of anatomy state that the female urethra is from 2½ cm. to 3 cm. long and about 7.5 mm. in diameter with a spindle-like dilatation in the centre. Herman found that the urethra in 56 patients between the ages of eighteen and seventy, varied between 7 and 12 mm. in diameter. Van de Warker believed that a urethra taking a bulb less than 16 F. was abnormal. Bugbee calls a stricture those in which there is difficulty in passing an 18 F. sound. Stevens says strictures above 18 F. will often cause symptoms and thinks 26 F. is normal. In 114 of his patients the urethral caliber averaged 22 F. and apparently they had lesions, his smallest was not above a filiform. None of my patients took above a number 18 F. and all had symptoms. I believe Bugbee is conservative and that a caliber of 22 F., as noted by Stevens, is at least a narrowing. The following table represents the calibers of my series:

Filiform stricture	1
No. 8 F.	2
No. 12 F.	5
No. 14 F.	8
No. 16 F.	12
No. 18 F.	7
Total	35

It is true I have seen cases above a number 18 F. that were suggestive of stricture, but I have not been able as yet to fully convince myself on that point. Further investigation in this line may change my opinion as it has regarding ureteral stenosis.

Location.—The stricture may be situated in any one portion of the urethra or it may involve the entire canal. The anterior one-third, particularly at the meatus, is decidedly the more common. A series of cases collected by Wynne, show four involving the entire urethra, nine at the external meatus, fourteen in the anterior third, seven in the middle third and four in the posterior third. In my present series the lesions were located as follows: External meatus 18, anterior third 12, middle third 1, posterior third 4.

Diagnosis and Prognosis.—The differential diagnosis presents no difficulties. Inspection, palpation, the use of the bulbous bougie or olive tip and the urethroscope should leave little in doubt. The etiological factor is important and may be difficult to determine. The prognosis depends largely on the

etiological factor. Soft infiltrations usually respond well to treatment, while the hard infiltrations are always a source of doubt as to their ultimate cure.

Treatment.—The female urethra is a delicate organ, very susceptible to injury, and must therefore be treated with care. Various authors have recommended gradual dilatation, modified rapid dilatation, rapid dilatation and electrolysis, in those cases where complete obstruction does not exist.

In the impassable strictures, internal and external urethrotomy have been recommended. If the stricture is found to be soft, as detected by the bulb, a careful modified rapid dilatation may be done. This will, however, usually necessitate the use of either a general anæsthetic or the use of caudal anæsthesia. In case modified rapid dilatation is used, I do not believe it ever advisable to dilate over six points at any one sitting, as, for instance, from a six to twelve. I once saw an operator use a small pair of forceps in an attempted rapid dilatation, with profuse hemorrhage resulting. Personally I should never recommend any rapid form of urethral dilatation. It is always best to begin the dilatation with the largest sound or bougie that will pass the stricture and then increase two numbers a week, until we reach the normal urethral calibre which I believe is around 26 F. After this, the large dilator should be passed once a month for a year and even after that it will be wise to have them come in every six months for a while to see if there is any evidence of a return.

In the hard infiltrations our treatment must be even more cautious than it is in the soft. While it is advisable to advance two numbers a week if possible, we should go a little slower where the yielding of the tissues is less as laceration readily occurs. We usually succeed in dilating a hard stricture but it takes a longer time and they are very prone to recur. Kelly has instructed some of his patients how to pass the sound so that the patient can keep up the treatment at home.

In those cases of impassable stricture of the female urethra, and even in some of the filiform strictures, it may be necessary to do a urethrotomy. If possible this should be an internal urethrotomy, somewhat as follows:

A filiform bougie should be passed and a Rand knife with a fine blade should be threaded over this. An attempt should then be made to cut through the stricture. After the urethrotomy, sounds should be passed as in the larger strictures.

Osgood states that in marked cases it is necessary to do an external urethrotomy through the anterior vaginal wall. This operation should certainly be avoided if possible. Hoehne has reported a case of gonorrhœal stricture in which it was necessary to resort to suprapubic cystotomy and retrograde catheterization.

In the treatment of those conditions due to tumor, radium or radical operation may be necessary. Kelly and Burnam also suggest the use of radium in dense strictures, but state they have had no personal experience with it.

I have not discussed rapid dilatation and electrolysis, because the former

is never to be used and the latter has little real value. A long experience with urethral lesions has taught me, that simple remedies and extreme gentleness are always to be considered. This applies particularly to the female urethra.

The following records are those of representative cases:

CASE I.—Mrs. J. G., white, married, age twenty-seven, U. S. Was brought to the hospital in an ambulance, complaining of pain over both kidney regions, most marked on the right, with inability to hold her urine.

Family history negative. Previous personal history: States that aside from measles in childhood she has always been well. Denies any venereal disease, but states that two months ago she had a small sore near her urethra. She was very anxious to get rid of this lesion and went to a dispensary for relief. The house officer gave her a black solution and told her how to apply it. The doctor said she was to return in a few days if she was not better and he would touch it up with carbolic acid. The sore did not improve but instead of returning to the dispensary she obtained some carbolic acid and applied it rather vigorously herself. The sore became very much worse for a few days and then cleared up by the use of a talcum preparation.

Present Condition.—Patient states that about one month ago, she noticed a more frequent desire to urinate, that her urine was cloudy with an unpleasant odor. She took some patent medicine without any relief. One week ago she noticed a tendency for her urine to dribble away and about this time began to experience a neuralgic condition over both kidneys but most noticeably on the right.

Examination reveals a small urethral orifice surrounded by a scar, through which we were able to pass a No. 8 F. olivary tip catheter and which on withdrawing was grasped at the meatus. The bladder urine in this case was very cloudy and a large amount was at once expelled around the catheter. Following this a No. 10 F. olive point was passed, with the result that the patient felt very much relieved. Subsequently she was dilated up to No. 26 F. at the rate of two numbers a week. There was a low grade, hard infiltrate in this case which extended a very short distance within the urethra. A small cystoscope later showed a clearing cystitis, which soon cleared with dilatation. Aside from a little pus the urine showed no other evidence of importance. Her blood chemistry was normal. Kidneys and ureters also normal. End result cure.

CASE II.—Mrs. McG., white, aged thirty-six. U. S. Family history negative. Previous personal history: Scarlet fever in infancy. Influenza two years ago. Denies any venereal infection, but sometime ago may be about five years, she had a severe attack of the whites that lasted about a year.

Present Condition.—Constant desire to pass urine which at times is very urgent, but succeeds in passing a very little each time. Examination shows a very small urethral orifice through which a filiform was passed with difficulty, but we were unable to pass anything else. The filiform was made fast and allowed to remain over night and an attempt made the next morning to pass other instruments without success. We then threaded a Rand knife over the filiform and forced it through a very hard stricture, which seemed to extend almost a centimetre into the urethra. Following this we were able to pass a number eight olivary tip and she responded well to dilatation, but is still having a sound passed every two weeks. A well-marked cystitis was present in this case, which slowly responded to treatment. Kidneys and ureters normal. Blood chemistry normal.

CASE III.—Mrs. Ha. J., age forty, white, Italian. Family history: Father died of unknown abdominal condition at fifty-five. Mother of pulmonary tuberculosis at forty-seven, three sisters and one brother alive and apparently well.

Previous personal history: Has had rheumatism for years. History of profuse vaginal discharge three years ago. Present complaint: Frequency, dysuria and at times

urgency and dribbling of urine. Examination notes at once a chronic vaginitis. Urethra seems to be surrounded with granulations, which apparently do not obstruct the orifice. Urethra readily admits a urethroscopic tube size No. 22, but which is stopped at about two centimetres by a hard obstruction. A distinct area of infiltration surrounding almost the entire urethra was seen at this point. A number eight urethral catheter was the largest we could get through into the bladder. This was left in until the next day, when we passed a number ten, and from this point on she was dilated two numbers a week up to 26 F. Urine in this case contained considerable pus and staphylococci, well-marked cystitis also present. Kidney and ureters later found normal. Cysto-urethroscopy showed the infiltrations around the deep urethra and bladder neck to be identical with those of the gonorrhœal infections. Discharged cured.

These cases are in sufficient detail to give a fairly good idea of what one may expect to encounter in the average run of cases.

SUMMARY

1. Stricture of the urethra in women is common.

2. The principal cause is a gonococcus infection.

3. The pathology is quite similar to that of urethral stricture in the male.

4. Its most common location is at the external meatus.

5. Most common symptoms are, frequency, urgency and dysuria.

6. The diagnosis may always be established by olivary tip, or bulbous bougies.

7. Prognosis is good in soft infiltrations, while that of hard infiltrations are doubtful.

8. Treatment is best carried out by the use of very gentle dilatation. Operative procedures always to be avoided if possible.

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WOUNDS OF THE LOWER EXTREMITY COMMUNICATING WITH A FRACTURE OR JOINT

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FROM THE FIRST SURGICAL DIVISION OF BELLEVUE HOSPITAL

COMPOUND fractures of the lower extremity are a fairly common type of injury encountered in a large hospital with a traumatic service. Less frequently seen are cases that have wounds connecting with joint cavities which may be accompanied with an open fracture or with a simple fracture in close proximity. In a period of four years, 1919–1922, 42 of the 439 frac-
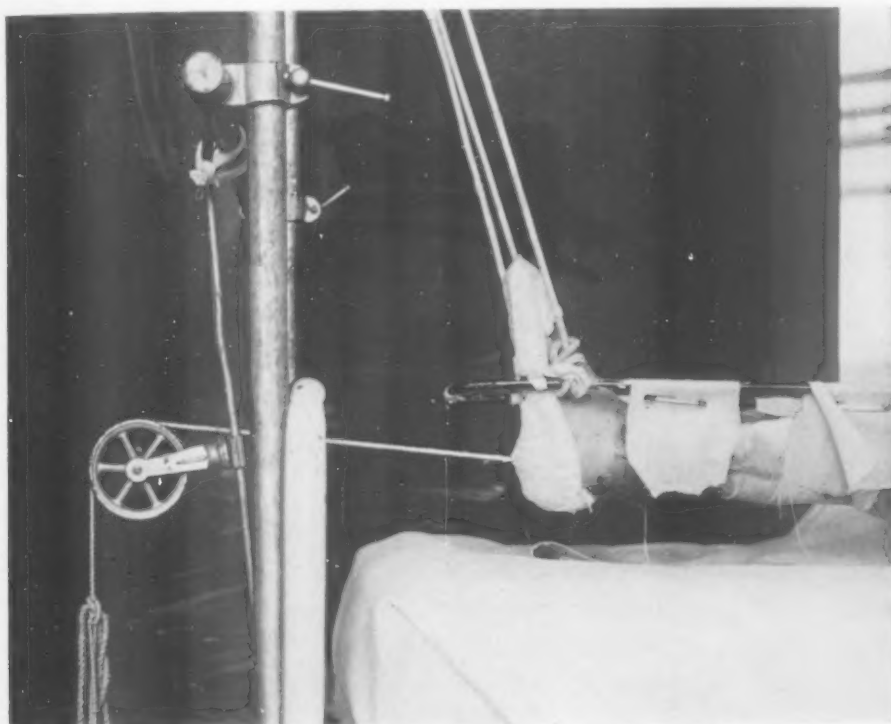

Fig. 1.—The plaster traction skate, lateral view.

tures of the lower extremity (femur, tibia, fibula, os calcis) treated on the First Surgical Division at Bellevue Hospital were of these two groups. A percentage of nearly 10 per cent. These cases tax the ingenuity and perseverance of the surgeon in order to obtain satisfactory anatomical and functional results. Besides the proper reduction and immobilization of the fracture, the injury to the skin and soft parts and the possible connection with a

joint cavity makes these cases much more difficult to handle than the simple fractures.

The cases in this series were divided as follows: Femur: Upper one-third, 1; middle one-third, 4; lower one-third, 4; total, 9. Knee-joint, 1; leg upper one-third, 4; middle one-third, 13; lower one-third, 14; total, 31; ankle-joint, 1; total of all cases, 42.

The ages varied from twelve to sixty-five (no children's service). There

FIG. 2.—The plaster traction skate, overhead view.

were 38 males and 4 females in the series. Length of stay in the hospital varied from 3 to 158 days. The mortality was 5 deaths, or 11.9 per cent.

Etiology.—Practically all cases were the result of some violent accident: run over by auto, struck by auto, crushed in elevator, or between trucks, fall out of a window, kicked by a horse, etc.

Whether the resulting injury was by direct or indirect violence, was difficult to determine in many cases. In most instances it was probably by direct violence.

Shock.—Patients were brought to the hospital in all degrees of shock. It was therefore necessary to treat this condition first when it was severe.

All but three cases were brought to the hospital shortly after the accident. Two of these developed osteomyelitis and the other required immediate amputation.

Type of Injury.—The cases varied from the simplest small punctured wound to the extensive laceration and maceration of the skin and soft parts. The fractures, from the simple usually oblique, to the comminuted fractures with or without loss of bone substance. In several cases there were evidences of injury to the larger blood-vessels and in one case the torn ends of both the anterior tibial artery and vein could be seen in the wound.

Treatment.—This was not uniform, depending on the amount of damage to the soft parts and type of fracture present. Generally it may be stated that in most of the punctured wounds where there was only a simple fracture, the wound was treated conservatively, injection of iodine sterile dressing, etc. The next type of case, where there was a laceration of the skin, and soft parts
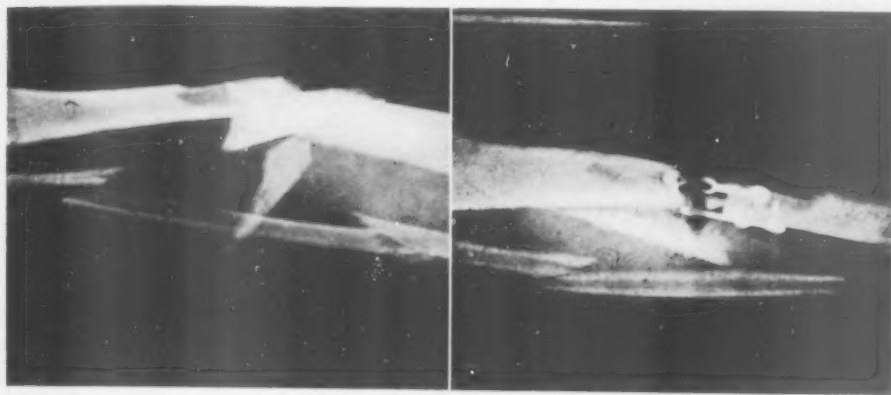
FIGS. 3 and 4.—Compound comminuted fracture of the both bones of leg, elevator crush, (case 2487). Showing condition after plating, (case 2487).

without too much maceration or ground-in dirt, were débrided, sterilized as much as possible and sutured. This procedure worked very well in 8 out of the 12 cases tried and certainly shortened their hospital detention considerably. The fact that it failed in four was probably due to the inadequate débridement in these cases or that the skin was not viable and sloughed away.

Where the traumatism had been too severe to allow primary suture different methods were used after débriding the wound. The wound being left wide open, it was either Dakinized, or packed with dichloramine-T gauze, or flavine gauze, etc.

As regards the fracture, the treatment depended on the condition of the soft parts and the fracture itself. Attempts were made to overcome the deformity or overriding as soon after the accident as possible and to immobilize the fragments by overhead suspension, traction and countertraction. Calipres when feasible were used. On several occasions where the wound was débrided and sutured and the bone fragments could be easily held in alignment, moulded plaster splints were used with very good results.

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In several other cases, where it was thought advisable to use calipres or the Steinman nail in the os calcis, traction was kept up by means of a plaster skate (Figs. 1 and 2). This worked very well, a traction force up to 20 pounds easily being maintained.

In all the series only two cases were plated, one a femur (History case No. 70), where the punctured wound healed and in spite of traction on the Hawley table and application of plaster case, overriding and posterior displacement could not be overcome. Calipre traction was not attempted, as the fracture was in the lower third of the femur and evidently extending into the joint. The plating was done three weeks after the original injury, at which time a collection of yellowish fluid was found around the fracture, the bony ends showed very little notching and the medullary cavity was shut off by a round mass of scar tissue. One week later there were distinct signs of infection and the wound was drained. A large amount of broken down clot was evacuated. It was interesting to find that the culture of the fluid found both at the first operation and on draining the wound, showed the same identical aerobic and

FIG. 5.—The exposed bone ends held by plate, (case 2487).

anaerobic gas-forming staphylococci. The wound finally healed, but the lower bony fragment was found to have angulated backwards loosening the plate, so it was removed six weeks later. At that time the plate was found to have broken. For some time later there was a discharging sinus, but one year after the accident there was firm bony union, with one-half inch shortening, and the knee motion showed complete extension and flexion to 85°.

The other case plated was a boy (2487) sixteen, who had his left leg crushed between an elevator and floor. Brought in shock, February 24, 1922. Treated for this first, then wound extensively débrided and packed with flavine gauze. There was a comminuted fracture of both bones of leg at the junction of middle and lower third. Leg put up in Thomas splint, overhead suspension and foot traction by means of plaster skate. Virulent infection of fascial planes. Six weeks later bone ends loose and practically denuded for a distance of one inch in a large wound cavity. Under gas anæsthesia wound cavity was cleansed and two short Lane plates were put in the apparently dead bone ends in order to immobilize the fragments and in the hope that granulations would develop and start some callus formation. This did occur, and four weeks later leg taken out of suspension and moulded plaster splints applied. Granulations filled up the wound and one plate removed. At the end of two months the second plate was removed with the upper sequestrum en masse. There was apparently good union,

the callus having completely surrounded the dead bone and replacing it. The wound gradually closed down to a small sinus to the remaining sequestrum and this was finally removed about ten months after the original injury.

Follow-up, January 17, 1923. Walks with slight limp, has slight posterior bowing of leg. Small ulcer at site of original wound. No sequestrum felt. Ankle and knee motion good.

September, 1923. Eighteen months after the injury. Patient has compensated for shortening and walks straight. Ulcer all healed and function of leg normal.

Amputation.—Ten cases, 23.8 per cent., came to amputation, seven of the femur and three of the leg. Four of the seven femur amputations died.

Before amputating every attempt was made to save the limb, only two amputations being done within 24 hours of admission.

Reasons for amputating: CASE I.—Twenty-two-year-old girl, had leg badly crushed
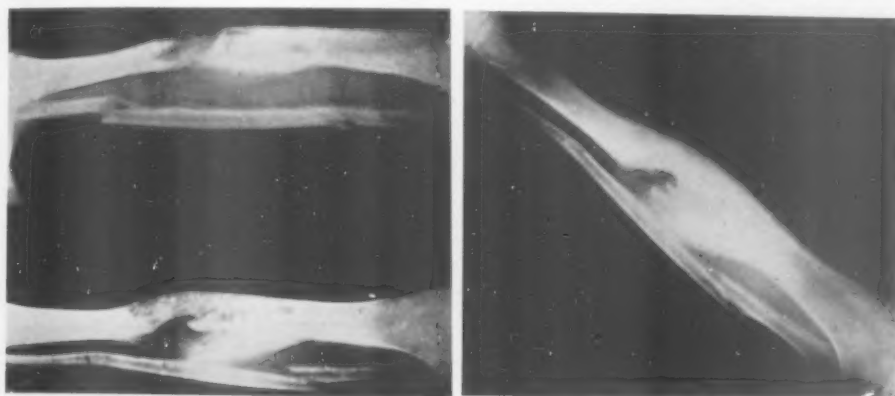
FIGS. 6 and 7.—Condition six months after plating; plates removed, upper sequestrum still present; note the callus formation, (case 2487).

in an elevator accident. Not in shock. No possibility of saving leg. Amputation below the knee. One year later walking with artificial leg, no limp, no pain.

CASE II.—Fifteen-year-old boy, had foot and ankle crushed in a railroad accident. Brought in 24 hours later. Evidence of gas gangrene, not in shock. Amputation mid-leg. Did well. One year later working, using artificial limb, no limp.

CASE III.—Twelve-year-old boy had foot and ankle run over by truck. Attempt made to save foot. Not successful, amputation on fourth day. Has had to have revision of stump. Now 28 months after accident, wound healed, but is not wearing artificial limb.

CASE IV.—Sixty-year-old man, leg caught in buzz saw, compound fracture of lower end of fibula, avulsion of skin and muscles up to knee. Developed gas infection, amputation under spinal anæsthesia at mid-thigh on fourth day. Two years after accident: All healed, uses crutch, will not use artificial leg.

CASE V.—Sixty-year-old man, had left leg caught in tow-line, causing a trision compound fracture above ankle joint. Developed severe infection in spite of extensive débridement and Dakinization. Amputation under local anæsthesia, mid-thigh. Healed well. Eleven months later, is wearing improperly fitted artificial leg, but gets around fairly well.

CASE VI.—Nineteen-year-old laborer, fell four stories, sustaining a compound inter-condyloid fracture of the femur. Treated for shock on admission. After 24 hours wound débrided and thigh placed in overhead suspension and traction applied. Developed gas gangrene on second day post-operative and amputation done at site of fracture,

leaving wound wide open. Positive B. Welchi culture. Did well. Three months later, wound revised, several small sequestra removed. Healed nicely. Twenty months after accident has good stump, walks well with artificial leg.

CASE VII.—Thirty-four-year-old fireman. Compound fracture of lower one-third femur. Crushed between two trucks. Had a large crushing wound above the knee-joint and communicating with it. Treated for shock, then wound and joint débrided and cleansed. Joint synovia sutured, rest of wound packed with flavine gauze. Put up in Thomas splint and traction applied. Did well for two weeks when he suddenly developed high fever and suppurative arthritis suspected. Next day signs were definite and amputation at mid-thigh done. Did not rally from amputation shock and died that night. On examination of the knee after amputation, it was found that there was extensive suppuration in it with extension into popliteal space. In this case up to the sudden rise of temperature there had been no premonitory symptoms.

FIG. 8.—Case 2835. Medial view of knee-joint with gas gangrene infection. Upper part of wound shows original laceration, lower part shows drainage incision into joint.

CASE VIII.—Male, sixty-four. Compound fracture lower one-third femur. Fell off low bench and hurt right thigh. There was a small punctured wound one inch above the patella. Some fluid in joint. Skin of thigh and knee cleansed, wound margin and subcutaneous tissue excised. Moleskin traction with Thomas hip splint. Developed wound infection. Amputation on third day, but did not survive, dying next day. Culture showed no anaerobic bacteria but many staphylococci and B. coli.

CASE IX.—Twenty-year-old salesman. Compound fracture middle one-third femur. Fell out of window. Treated for shock and laceration cleansed. Next day wound extensively débrided and bone fragments put in alignment. Dakin treatment. Suspension traction. Temperature kept steadily high, 102–104°, and on fifth day extensive incisions made laterally and posteriorly, through-and-through drainage. Thick pus evacuated but no gas. Patient septic but blood culture negative. On the fourteenth day amputation done as patient seemed to show no resistance to local infection. Did not improve, and died next day.

CASE X.—Fifty-five; stableman. Compound fracture upper one-third femur. Kicked by horse. Two cm. punctured wound on right thigh compound with fracture. Considerable laceration of soft parts. Débridement and Dakin gauze packing. Distinct

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crepitus appeared in wound on third day. Wound opened and extensive incisions made. Showed no improvement and thigh amputated same night, but patient died shortly after. Clinically a case of gas gangrene, but cultures were negative.

Mortality.—As has been stated previously there were five deaths, the last four cases above cited in which amputation was done and the following case.

CASE XI.—Fifty-four-year-old carpenter, with a compound fracture of the middle one-third of the femur and a fracture of both bones of the leg. He had been crushed between an elevator and a floor. Wounds débrided and cleansed on admission. Traction difficult to apply and maintain on account of extensive wounds. One week after admission infection not controlled and gas gangrene suspected, culture negative. Too weak to stand amputation and died on sixteenth day after accident.

These five deaths make a mortality rate of 57 per cent. in the femur cases. A high mortality but every one of these cases were desperate cases, the infection apparently being the overwhelming feature. As far as the age is concerned it does not seem to have any bearing on the deaths, as two of the femur amputations that survived were both men of sixty years of age.

Infections.—Many of this series, especially the cases with small punctured wounds and the

FIG. 9.—Case 2835. End result showing scars and full extension of knee.

ones that had extensive débridement and suture, healed readily without infection. The most fearsome type of infection was the gas gangrene and this was found present clinically in two and both clinically by culture, etc., in three others. All five cases had distinct subcutaneous crepitation, gangrene of the muscles, and the presence of the characteristic odor. Three of the five got well and they were the ones in which positive cultures were obtained. Other

types of organisms found in the infected cases were both aerobic and anaerobic staphylococci and the B. coli communis.

Complications.—None of the cases had a secondary hemorrhage.

Seven (16.6 per cent.) cases developed osteomyelitis. One of these was in a case that refused any surgical operation for seventeen days and only consented when there was an acute cellulitis around the wound. Two others were cases that were twenty-four hours old before being brought into hospital. The other four were in cases that had extensive laceration of soft parts and
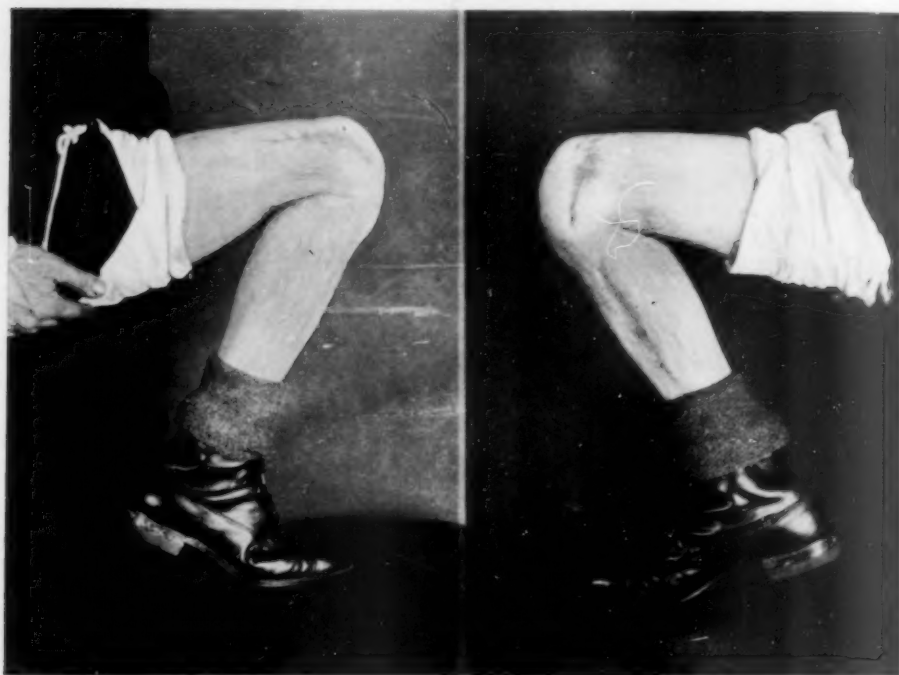

Fig. 10.—Case 2835. End result showing scars and degree of knee flexion.

comminution of the bones. All but one of the seven cases have been followed for at least one year, and five of the six are healed.

There were three cases of delayed union, two in cases of osteomyelitis. Of the two latter, union was firm in six months and in the other ten months after the accident. The third case had no real osteomyelitis, but had an ulcer of the site of fracture (just above the ankle). She had a bad fracture, bone ends hard to keep in alignment. Negative Wassermann. Had fibrous union and ulcer healed in four months. After five months, an injection of 15 c.c. of her own blood was made at the site of fracture and shortly after union became firm.

The following additional cases are reported to show good results obtained with different therapeutic measures:

CASE XII.—569. G. D., laborer, twenty-four, run over by taxi. Compound comminuted fracture of upper end of tibia, wound and fracture communicating with knee-joint.

Extensive débridement, cleansing of knee-joint with ether removing blood clots. Knee-joint capsule sutured, skin sutured and circular cast from mid-thigh to toes. Did well, primary union. Five months after accident walks with slight limp, has full extension of knee, flexion to 90°.

CASE XIII.—1725. M. M., twenty, dressmaker. Fell out of first-story window, sustaining a compound dislocation of left ankle, with fracture of external malleolus. Laceration transverse across outer side of ankle 5½ inches long. Wound débrided, irrigated with 1-5000 acriflavine. Soft parts and skin sutured loosely, deformity corrected. Plaster case with window. Two days later some tension at both ends of wound and several sutures removed, allowing better drainage. The case was also cut a few days later and leg and foot put up in a strong posterior moulded plaster splint. She improved steadily, wound closed in less than a month, early motion begun and patient discharged in seven weeks. Wore a brace for several months, the œdema gradually subsided, and ankle motion good. One year after the accident, patient walks without limp. Has slight œdema above wound, but none of foot. Can stand all day and motion 100°.

CASE XIV.—2835. C. S., thirty-five, laborer. Laceration of thigh communicating with knee-joint, fracture of head of fibula. Run over and dragged by truck. Admitted to hospital with what appeared a contused superficial wound of leg. Cleansed superficially and dry sterile dressing applied. On second day after admission, temperature had risen to 102° and patient complained of severe pain in knee. It was found swollen, subcutaneous crepitation present, evidences of gas gangrene. Brought to operating room, two wide lateral incisions made into knee-joint from upper level of subcrural bursa down to tuberosities of tibia. All necrotic muscle excised and knee-joint flushed out.

Culture and guinea-pig inoculation for B. Welch positive.

Active Willems treatment for knee-joint instituted.

Patient improved, wounds became clean, and finally closed. Eight months after accident has perfect weight-bearing leg with normal knee motion.

CASE XV.—2854. H. M., laborer, thirty-eight, slipped, and in falling kicked his right leg with left foot, sustaining a compound comminuted fracture of lower third of leg. Soft parts débrided and several long loose fragments of tibia removed. Wound cleansed and then sutured without drainage. Posterior and lateral moulded splints applied. Wound healed well except for slight superficial skin sloughing at lower angle. No osteomyelitis. Firm union in eight weeks. Walks well seven months later.

In closing, I wish to thank Dr. R. Hooker for the privilege of allowing me to compile and report these cases from files of the First Surgical Division of Bellevue Hospital.

SIMULTANEOUS DISLOCATION OF BOTH SHOULDER JOINTS *

By Aimé Paul Heineck, M.D.

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Simultaneous traumatic dislocations of both humeri form the subject matter of this paper, based exclusively upon the analytical study of all cases (fifty-eight in number) reported in the English, French and German literature from 1836 to 1923, supplemented by the clinical observation of one personal case. All the cases were (a) in location, bilateral; (b) in occurrence, simultaneous or immediately successive, and always caused by the same accident; (c) in nature, complete; (d) in causation, unquestionably traumatic. With one exception (32), the condition had never previously occurred in the same individual. In another case (28), both shoulders had been dislocated, the left six years, the right fourteen years previously. We have not attempted to discuss completely bilateral shoulder dislocations; only clinical facts and anatomical lesions reported in the original articles have been analyzed and summarized.

These dislocations differ in type, in etiology, in clinical manifestations and present various associated injuries of the articular and peri-articular tissues (osseous, nervous, vascular, etc.). Early and complete reduction, correction (operative or non-operative) of the co-existing complications, and institution of judicious after-treatment (massage, mechano-therapy, electricity, etc.,) minimize, in fact almost always completely overcome, the anatomical deformity and the functional disability incident to shoulder dislocations.

We discarded cases like the following: " Bilateral Dislocations of Shoulder with Marked Muscular Wasting" (60). The patient, a seventeen-year-old girl, an epileptic since birth, gave no history whatever of previous shoulder injury. Examination revealed an incomplete forward dislocation of both humeri with marked limitation of joint movements and evident wasting of the right deltoid and spinati. Skiagrams of both shoulders did not show any abnormality in the bone tissue. This case was eliminated because (a) it was an incomplete dislocation; (b) it was not traumatic in origin.

Habitual or recurrent dislocation is a condition of joint instability characterized by repeated, frequent and complete abnormal separation of contiguous joint-surfaces (65). It occurs upon slight provocation and is often consecutive to a traumatic dislocation. It may be associated with, or determined by (a) abnormal laxity or bagginess of the articular capsule, the resultant of a previous injury; (b) paralysis of one, of several, or of all the periarticular muscles. The tonicity of the periarticular muscles maintains in normal contact the glenoid cavity and the articular head of the humerus. (c) Nonunion or a faulty union of fractures of the glenoid cavity, of the articular

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* The numbers in the article refer to illustrative cases, for which see the bibliography.

head of the humerus, etc.; (d) non-union or vicious union of a fracture of one or of both humeral tuberosities; (e) traumatic detachment from their insertion of one or more of the rotators of the humeral head. When the external rotators are detached, with or without a lamella of bone, the action of the subscapularis predominates and a forward displacement of the head of the bone is easily effected. When the subscapularis is detached, with or without its osseous insertion, the action of the external rotators is no longer counterbalanced and backward dislocation of the humeral head may result; (f) traumatic separation of one or more of the upper epiphyses of the humerus; (g) anatomical defects of the glenoid cavity.

Allen (6) reports a case of "Simultaneous Dislocation of Both Shoulders." His patient, in the previous four years, had had four dislocations of the right shoulder and three of the left. This case and similar cases (62, etc.,) were rejected because (a) in their causation, trauma is not the determining etiological factor; (b) their frequent recurrence labels them habitual or recurrent dislocations (66); (c) they do not present the essential desideratum, that of being simultaneously bilateral; (d) they were associated with or consecutive to one or more of the lesions or conditions known to predispose to habitual dislocations.

Incomplete (60), congenital (64, 65, 67) pathological (63) or spontaneous dislocations and those that were not simultaneously bilateral, are outside of the scope of this paper.

The fifty-nine cases herein considered present the following features: (a) All were traumatic in causation and complete in nature. (b) All were bilateral in location, though not always symmetrical. (c) All were simultaneous in incidence, both shoulders being dislocated within a few minutes' interval. Though not always due to the same immediate exciting factor, they were all caused by the same accident. A passenger fell with others from the top of an omnibus as the vehicle overturned. It was his belief that, in falling, he had dislocated one shoulder, and that his other shoulder had been dislocated by a friend falling on it (26). (d) All the joints affected were, previous to the dislocations, free from structural abnormalities, as far as can be determined by the text.

Bilateral shoulder dislocations occur in both sexes and at all periods of life. Our series of collected cases show that they are more frequent in males than in females: forty-seven males and eleven females. My patient was a housewife fifty-six years old.

The external violence which dislocates the humerus in adults, in children commonly gives rise to elbow dislocations, to fractures of the clavicle, to humeral epiphyseal separations. Bilateral shoulder dislocations are very rare before the twentieth year. The youngest patients in our series were a male nineteen years old (31) and a female twenty-one years old (24). In advanced life, shoulder dislocations are equally rare, the oldest patient being a female eighty-six years old (20). In eighteen cases the age incidence is not

stated; in the other cases, it was as follows: Nineteen years, 1 case; 21 to 30 years, 6 cases; 30 to 40 years, 5 cases; 41 to 50 years, 11 cases; 51 to 60 years, 10 cases; 61 to 70 years, 5 cases; 71 to 80 years, 1 case; 86 years, 1 case.

Bilateral simultaneous shoulder dislocations are either caused by external violence, direct or indirect, or by muscular action, acting singly (25) or co-jointly (18). Violent shocks or wrenches acting simultaneously on the two arms can produce simultaneous bilateral shoulder dislocations (45).

The mechanism of displacement can only be surmised (twenty-five cases). (a) In cases not reported with adequate data. Case 37 gave no history of previous dislocations and though both shoulders were considerably bruised and swollen, it remains a question of conjecture whether one or both dislocations were caused by the fit or the fall. (b) In cases in which the mechanism of displacement is either not stated (dissecting (41) or post-mortem-room subjects (3, 45), or not described in detail. In case 43, a woman fell three and one-half feet from a stepladder, with both arms extended over her head; in case 54, a woman fell forward head-first from the platform of a moving street car; in case 19, a chain springing upward caught the patient under the arm, threw him aloft, and he fell to the ground on the other arm. (c) In cases in which the productive violence is complex in nature. In case 39, a workman working in a pit, suddenly tapped water; the latter came with such force that he was washed down the dip a distance of sixty feet. In case 40, a man (age not stated), oiling the fly-wheel of an engine in motion, entangled his shirt sleeve in the machinery. He instantly grasped the spokes of the wheel, was whirled around several times, and then fell to the ground. His clothing was torn to shreds. Five minutes later, he was found in a state of deep syncope; his jaw and both shoulders were completely dislocated.

In five cases (11, 21, 30, 55, 57) it is definitely reported that the dislocations were caused by violent muscular contractions incident to epileptic convulsions. In case 12, puerperal convulsions were the causative factor. In five other cases muscular action was the provocative force. In case 1, the displacement occurred during unusually violent efforts to control a struggling animal; in case 6, the patient, raising over his head a calf, was forced, by the animal's struggles, to let it fall backward. In case 14, the displacement followed the contraction of the great pectoral and latissimus-dorsi muscles of each side. The patient, standing insecurely on the edge of a loaded coal truck, attempted to maintain his balance by resting one hand on the coal and the other on the arched end of the wagon. His feet slipped, and, while endeavoring by a sudden effort to save himself from a fall, he " felt something give " at his shoulders. On rising, he was unable to use either arm. " When he slipped, the weight of the trunk fell, in part at least, on the outspread arms; in the sudden effort to support the trunk, the two pairs of muscles just mentioned were probably among the first to contract. Acting simultaneously, the glenoid cavities being the fulcra, their normal effect is to press the arms to the side. On the present occasion, however, the hands became the fulcra, being firmly supported on the wagon, and the head of each humerus was jerked inward by

muscular contraction at a moment when the bones were in a position favorable to the displacement."

The remaining cases were caused by external violence, the causative force being applied either directly to the shoulder, or transmitted indirectly to the articulation, as by a fall upon the outstretched hands (17), upon the extended elbows (23).

In the following three cases, the injury can be attributed to direct violence. In case 46, the patient, while conveying a barrel down cellar steps, slipped and fell upon his abdomen and right side. He was caught between the steps and the barrel, the latter passing over his back. In case 24, the patient, during a heavy storm, was walking along a high stone wall. The wall suddenly crumbled, and striking the patient's right shoulder, threw her forcibly to the ground directly on her left shoulder, and buried her in the débris. In case 31, a miner pushed a heavy truck against a prop supporting the roof of a coal pit; roof gave way and fell on the patient's back, burying him in a heap of rubbish. He was finally pulled out by the right arm.

Examples of dislocations due to indirect violence follow. In case 5, patient was thrown from his cart and fell head downward, alighting upon his hands. In case 8, a porter, to receive a sack of grain upon his back, leaned forward and held on to the rear of his wagon with both hands. While still holding fast to the wagon, the sack fell heavily on the back of his neck and violently forced the trunk of his body forward. In case 45, the forcible elevation and traction of the arms caused the head of the humerus to impinge on the lower border of the capsule, thus favoring its exit. In case 16, patient, working upon a scaffold, lost his footing and fell, striking the ground with both elbows at the same time. In case 17, the patient fell from his carriage, his arms extended in front of him; the force of the concussion was received upon his hands. In case 22, the forcible elevation of the arms against the body by a fall through a narrow trapdoor, thrust both humeral heads out of their sockets. In case 29, patient fell from a tree, a distance of forty feet, on his outstretched arms. In case 34, patient fell into the water. He was pulled into a neighboring tug by traction on his extended arms and immediately felt severe pain in both shoulders and arms; both humeri were dislocated. In case 36, a stout woman, tripping over a carpet, fell forcibly forward, the weight of her body being received on both outstretched forearms and elbows. My patient fell from a ladder, striking the ground with both hands, arms and forearms being fully extended.

From the standpoint of prognosis and treatment, shoulder dislocations can be classified into recent and old. Dislocations become old through faulty diagnosis, faulty attempts at reduction and often through surgical neglect. In old dislocations, the articulation itself and the peri-articular tissues are the seat of structural changes. The anatomical relations of the head of the humerus and of the glenoid cavity are altered. The glenoid fossa may be partly or wholly obliterated by cicatricial tissue, calcified cartilage, etc (52). Case 41 presented fully developed false shoulder-joints. In old dislocations, the

various bloodless manipulative and other non-operative procedures are often, owing to these changes, powerless to effect either an anatomical or a functional cure. There were eight old dislocations varying in age from six weeks (42), nine and one-half weeks (29) to several years (21). Cases 12, 14, 23, 52 and 58 were of several months' duration.

All cases not referred to before (dissecting- and autopsy-room cases excluded), were recent in nature. My case (59) was seen and reduced two hours after its occurrence.

There are several anatomical classifications in current use. Lack of uniformity in nomenclature is regrettable, is misleading. So as not to vitiate the accuracy of this analytical study, we have, in each case, quoted the reporter's words. In thirteen cases (1, 3, 4, 5, 11, 12, 25, 26, 27, 30, 40, 41, 53) the anatomical type of displacement is not stated or is not precisely described. The exact anatomical relations of the displaced head are either not given or unqualified expressions as " backward " or " downward " displacement are used.

In thirty-six cases both dislocations were of the same anatomical type, and were symmetrical or closely symmetrical. In case 56, a double " luxatio erecta," the humeri were fixed in vertical elevation, both glenoid fossæ were empty, both shoulders presented a distinct hollow beneath the acromion process, and in each axilla the humeral head could be palpated as a hard, globular mass. In a bilateral subclavicular dislocation (13), each humeral head was lying against the second and third ribs, just below the clavicle. In case 34, a bilateral intra-coracoid dislocation, the head of each humerus could be felt to the inner side of its corresponding coracoid process; the inward displacement was more marked on the left side. Case 57, belongs to the subacromial and case 18 to the supracoracoid type (verified at autopsy). Case 55 was a bilateral and symmetrical subspinous dislocation, each humeral head being palpable beneath the spine of its corresponding scapula.

Different reporters use unlike terms to designate like displacements. The description given in the case reports, does not enable one to differentiate subglenoid (43 and 52) dislocations from those termed axillary. Nevertheless, we use here the nomenclature found in the original publications. In two cases (36, 44), the reporters state that the head of the bone was displaced into the axilla. In my case, the head of the bone was palpable on each side immediately below the coracoid process of the scapula.

In six cases the dislocations were bilateral and in the same general direction, but dissimilar in anatomical type. A subglenoid and a subcoracoid dislocation were present in three cases (2, 36, 47). In case 7, the left humerus was displaced into the axilla, the right under the clavicle. In case 33, the head of the left humerus was immediately below the subcoracoid process, the head of the right humerus had ruptured the muscle in its path and was subclavicular in location. In case 9, the left humeral head rested on the anterior margin of the lower border of the scapula just below the glenoid cavity, and the right humeral head was prescapular, lying between the anterior

surface of the bone and the subscapularis muscle. In case 15, the left humerus was below the coracoid process and on the right side, the head of the humerus could be felt upon the dorsum of the scapula, a subspinous dislocation. Case 20 presented a subcoracoid and an intra-coracoid dislocation.

Very little demonstrated pathology is recorded in the case-reports because (a) these dislocations, unless complicated by great shock (56), associated injuries (3), senility, marasmus (20), etc., are not fatal and therefore rarely come to the autopsy table; (b) unless irreducible by bloodless methods, they do not reach the operating-table. To conform to the plan outlined at the beginning of the article, we record only the pathology actually demonstrated and reported in our series of cases.

In shoulder dislocations, the articular and peri-articular soft tissues (20) are contused, lacerated and infiltrated with blood. The synovial fluid is blood-tinged and increased in amount (13). A tear of the joint capsule (9, 13, 20), through which the head of the bone has escaped from its normal habitat, is present in all cases. The greater frequency of forward and downward displacements is due to the fact that the capsular tear is usually on its anterior and inner portion (20), at its lower aspect (56). The capsule at its lower portion is not reënforced by any ligament or muscle. The capsular tear and the untorn portion of the joint capsule control, determine in a large measure, the type of displacement. In some cases there is recorded a detachment of the subscapularis, the teres minor, the supra- and infra-spinatus muscles, singly or together, from their insertion. At times a bony fragment consisting of the outer shell or cortical layer of the humerus is torn off with these muscles. Fractures of either the greater or lesser tuberosities are not uncommon. They vary in extent, may constitute a formidable obstacle to reduction and predispose to reluxation.

The diagnosis of these fractures is difficult (9) because the detached fragment often cannot be felt and crepitus often cannot be elicited. The only certain means of diagnosis is by radiogram; but one must bear in mind that a torn subdeltoid bursa full of clotted blood may, by throwing a shadow, simulate a bone-fragment.

The following associated injuries are recorded: Bilateral fracture and detachment of the greater tuberosities (9, 58), fracture of the right coracoid process near its base (9), compression of the axillary nerves and vessels (56), contusions of various portions of the body (31, 43). In case 46, the fracture of the lower end of the right radius is to be considered a related injury. As distal, though not related, associated injuries, the following are reported: Skull fracture (9), fracture of the lower third of the femur (35), compound fracture of the middle of the left leg (39), complete (bilateral) dislocation of the jaw (40), gangrene of right foot (52). Fracture of the surgical neck of the humerus was not present in a single case. It is not rare in unilateral dislocations.

There are symptoms (pain (5, 23, 45); loss of function (21, 54); rigidity (42); "patient is unable to use his arms" (48, 58); in my case the loss of

function and joint-rigidity were complete) common to all shoulder disloca-
tions. There are symptoms that occur only in certain types of displacement:
the location of the humeral head, the position of the elbow, etc., differ in the
various anatomical forms. In complicated cases, one finds, in addition, the
alterations of function, of structure and of contour due to the co-
existing injuries.

In all bilateral shoulder dislocations, note the direction of the axis of
each humerus, note the relations of the bony landmarks of the shoulder
region, note the extent of functional impairment and the degree or range of
joint-mobility. Any deviation from the normal is symptomatic of under-
lying pathology.

In unilateral dislocations, to establish a diagnosis, one compares the
injured shoulder with the unaffected. In bilateral dislocations, the clinician
cannot avail himself of this aid as both shoulders are, most always, symmetri-
cally deformed, the measurements of both sides often not differing half an
inch (31); at times they are similar (54). In my case, the measurements
of both arms were practically identical. Secure full exposure of both shoulders
by divesting upper portion of chest of all unnecessary clothing.

The rotundity of the shoulder depends partly on the head of the humerus
being in its proper place and partly on the integrity of the deltoid muscle.
Therefore, in all inward, downward or backward displacements of the head of
the humerus, the normal contour of the shoulder is lost and there is present
a double deformity: a distinct flattening of the shoulder region, due to the
absence of the head of the bone from its normal place, and an abnormal
bulging due to the presence of the displaced head in its new habitat. In
dislocations, the deltoid slopes straight from the acromion, or sinks in, having
an indented appearance at its insertion. An empty glenoid cavity (23, 54)
and abduction of the arm, accompany all shoulder dislocations. " The round-
ness of the shoulder was quite gone " (15). " Both shoulders were flattened
and both arms were abducted from the chest wall " (45, 54). In my case,
though patient was obese, the emptiness of the glenoid cavities could be
demonstrated and the flattening of both shoulders was typical.

In all shoulder dislocations, the head of the bone can, by painstaking
inspection and palpation, invariably be detected in an abnormal location.
" The head of the humerus could be readily felt under the pectoral muscle "
(2). " Head of bone could be readily felt upon the dorsum of the scapula "
(15). " In each axillary space, the head of the corresponding humerus could
be palpated " (22, 24). In case 34, the head of the right humerus was
below and a little to the inner side of the coracoid process; the head of the
left humerus lay farther inward. In cases 23 and 40, and in my case, the
humeral heads could be felt under the coracoid processes; rotation of either
arm caused rolling of the corresponding ball-shaped head.

In all bilateral dislocations of the humerus there is a distinct hollow or
hiatus beneath the acromion process (2, 44), this hiatus being less noticeable
in subacromial dislocations (57).

In old and recent dislocations, the deformity is so characteristic that the diagnosis is often made by inspection and palpation. In obese and muscular individuals, exact diagnosis is more difficult. "There was a hiatus under each acromion, but in consequence of the mass of adipose tissue it was not possible to feel the head of the humerus in the axillary space" (44).

In all cases, it is advisable to have both shoulders radiographed. The radiograms serve as a record, as a guide; they often clear up many unsuspected conditions (54, 58), and establish the diagnosis upon an undisputable basis (52). "The head is displaced downward; it is entirely below the glenoid cavity, and is away from the thoracic wall" (56). In my case, on both sides, the radiograms showed distinctly the integrity of the acromion, of the coracoid process, of the clavicle, of the head and anatomical and surgical necks of the humerus. The acromio-clavicular articulations were normal. Each humeral head was away from the chest wall, was away from the glenoid fossa and immediately below the coracoid process. Radiograms show the exact location of the humeral heads, reveal the presence or absence of complicating osseous lesions: fractures of the humerus, of the surgical neck and coracoid process of the scapula. They remove doubts from the clinician's mind. Stereoscopic pictures are less liable to misinterpretation.

Complicating injuries of the nervous system are evidenced by motor, sensory and trophic disturbances. Some of these nervous lesions are irremediable; others, such as contusion, compression, stretching and division (partial or complete) give, under appropriate treatment, a hopeful prognosis. At the first examination, one should exclude an involvement of the circumflex or other nerves; sometimes, the nerve involvement affects all the muscles of the upper extremity. "One month after reduction of the dislocations, patient was unable, owing to a partial paralysis of the deltoid, to completely elevate left arm" (45). In non-reduced cases, the nerves may be compressed by scar-tissue. By taking the pulse on each side, one is enabled to ascertain the presence or absence of important vascular injuries.

Including my personal case, we analyzed fifty-nine cases. Six cases, for various reasons, were untreated. In case 3, patient was dead at time of diagnosis. Case 9 died from a skull fracture five hours after being brought to the hospital. In case 13, patient died from a broncho-pneumonia shortly after admission to hospital and before the dislocations were reduced. Case 18 was an autopsy-room subject. Case 41 was a dissecting-room subject. In case 21, for some reason not stated, no attempt at reduction was made. To these may be added a case of double luxatio erecta (56); the dislocations were reduced, but patient died of shock from the associated injuries. There were eight old dislocations; their treatment and the results obtained are discussed at the close of the article.

Recent dislocations are reducible or irreducible. Primary irreducibility is usually due to some complication. Associated fractures, detachment of either humeral tuberosity, especially if the detached fragments lie in the glen-

oid cavity, hinder reduction, predispose to recurrence. The indication to suture or nail the detached fragment to its normal place may prevail.

Recent dislocations call for immediate reduction. At the outset, let us emphasize that the treatment of choice is non-operative. In the treatment of shoulder dislocations, operation is a last resort. Only two recent dislocations were subjected to operation. In case 34, the dislocation on the right side was reduced with the aid of ether anæsthesia without much difficulty. All manipulative efforts failed to reduce the one on the left side. On the following day the joint-cavity and the left humeral head were exposed by an anterior incision. The humeral neck was crossed above on its outer side by the untorn tendon of the subscapularis.

Anæsthesia facilitates reduction, it abolishes pain, it overcomes muscular spasm and the patient's resistance; with its aid, one can by gentle manipulation gradually break up adhesions opposing reduction (36). It is especially serviceable in muscular individuals (35).

In five cases (8, 28, 38, 53, 54) in which reduction was obtained by non-operative methods, the text makes no reference of the use of anæsthesia. In nineteen cases (1, 2, 4, 5, 7, etc.), non-operative methods, unaided by anæsthesia, successfully effected reduction. In case 33, the left humerus was reduced without anæsthesia, the right humerus, with anæsthesia. In twelve cases, to effect reduction, non-operative methods had to be supplemented by general anæsthesia (19, 20, 45, chloroform; 36, 43, ether, etc.). In my case, to secure reduction, the patient was etherized.

In every recent case but one (34), in which non-operative methods were employed, the head of the bone was successfully replaced in its normal habitat. At times, one side is reduced easily, but to effect reduction of the opposite side, difficulty is experienced (39, 44); anæsthesia may be required (33, 36). In many cases, the clinicians noted the occurrence of a peculiar jerk, of a distinct audible snap upon return of the bone to its socket (1, 2, 4, 5, 15, 20, 46, 51). Instant relief from pain often follows reduction. In seven cases (6, 8, 25, 27, 30, 47, 57), it is not stated that attempts at reduction were made.

Among the non-operative methods, Mothe's method was used in one case (20), Kocher's method in ten cases (22, 32, 45, 46, 49, 50, 51, 53, 54, 59). In the remaining twenty-seven cases reduction was effected by various bloodless manipulative procedures supplemented by extension and counter-extension (1, 5, 24, 31, 44, 55). The extension is made by the operator, his assistants, weights or pulleys, counter-extension, by axillary pads, by heel in the axilla (2, 4, 7, 15, 16). In fifteen cases the method employed to secure reduction is not described in detail (10, 11, 17, 19, 26, 28, 33, 35, 36, 38, 39, 40, 43, 48, 56).

After reduction, the shoulder must be immobilized long enough to allow the repair of the capsular tear. It is also imperative that passive and active motion, and massage, be instituted early enough to avoid ankylosis.

The treatment of old dislocations requires great care and individualization. Owing to the close interrelation of treatment and results, it is best that they

be discussed together. There were eight old dislocations of from six weeks to several years' standing. In old dislocations, the difficulty of reduction is due to various factors: Cicatrization and contraction of the capsular tear (52), inflammatory adhesions binding the head of the humerus to the surrounding structures, obliteration of the glenoid cavity, adhesion of the joint-capsule to the periphery or to the entire glenoid fossa, interposition of tendon or muscle, etc.

Some old dislocations are amenable to bloodless manipulative procedures, others require operative aid. Though not always successful, the former should always be first attempted; successful bloodless manipulative methods secure better functional and anatomical results than operative treatment. When manipulation, traction by pulleys, etc., supplemented by anæsthesia, fail to obtain reduction, operation, if not contra-indicated, is to be performed. Arthrotomy permits direct inspection of the articulation and of the contiguous structures. It enables the operator to determine, to remove obstacles to reduction. "The tendon of the triceps prevented the head of the bone from re-ascending and slipping back into its normal place (56)."

Unreduced dislocations are accompanied by deformity and disability, varying in degree, but permanently impairing the earning capacity of a hand-worker. Operative treatment has a very low mortality, almost nil, and though final results are not always perfect, pain and circulatory disturbances are relieved. There follows a very fair restoration of function.

In elderly people, fracture of the shaft of the humerus has resulted from forcible attempts at reduction of old shoulder dislocations. During careful (author's words) attempts at reduction of a dislocation of several months' standing, the humerus was fractured immediately above the insertion of the deltoid muscle (52). Atrophy, adhesions of the surrounding muscles and soft parts and adhesions of the torn joint-capsule, all these tend to make, at times, reduction by manipulation difficult, impossible, or extremely dangerous. In case 12, seven months after the accident, reduction was secured by bloodless methods. In case 14, reduction by pulleys and counter-extension was half-heartedly attempted, was unsuccessful. The case was abandoned to nature; deformity and disability persisted. Case 21 was untreated. Case 58 was of six months' standing. Attempts (Kocher and others) at reduction under anæs-thesia were unsuccessful. Patient being sixty-five years old, operation was not advised. Case was treated by massage, active and passive motion, with indif-ferent results. In case 23, though the humeral heads had remained out of their sockets twelve weeks, reduction was effected by manipulative methods (eleva-tion of the arms, etc.,) with the aid of anæsthesia. Joint-motion was not fully recovered. On right side, arm could be abducted to the horizontal; on left side functional recovery was more incomplete. In case 42, the value of judi-cious persistency is demonstrated. One month after the accident two attempts, two days apart, were made under anæsthesia to reduce the dislocation with the aid of pulleys. They were unsuccessful. Two weeks later another surgeon effected reduction by the aid of pulleys.

Resort to a cutting operation when convinced of the futility of further use of non-operative procedures. In the young, reduction is more easily effected, presents less difficulty than in adults, and bloody intervention is rarely justified. In case 52, during attempts at reduction of the dislocation on the one side, the humerus having been fractured above the insertion of the deltoid, the joint was opened. Owing to the partial obliteration of the glenoid fossa by cicatricial tissue and by osteophytic outgrowths, reduction was difficult. The glenoid cavity was cleaned out, and cicatricial bands opposing reduction were cut. The head of the bone was replaced in its normal position. Three months later, the arms could be abducted to the horizontal. The remaining case 29 was operated on by Sir Joseph Lister nine and one-half weeks after the accident. Each humerus was protruded through the incision and all the rotators divided at their insertion; at the second attempt "the pulleys drew the bone into the proper position." Two months after discharge, patient came to the hospital for inspection, and it was seen that arms could be raised to a right angle with only slight movement of the scapula; rotation was much improved. Patient stated that he could do hard agricultural work as well as ever.

The incision giving access to the articulation may be made along the posterior or the anterior axillary fold. All cicatricial bands impeding reduction are cut, muscles preventing reduction are divided and subsequently sutured. The head of the bone being replaced into the joint-capsule, the latter is closed as completely as possible.

In the recent dislocations, the ultimate results are recorded in some cases; not mentioned (twenty-eight cases) in others. In eight cases (7, 10, 22, 24, 40, 48, 57, 59) recovery was complete. In some of the remaining cases, the late results are reported as follows: "Eight weeks after accident patient was quite well" (31); "seven weeks after accident patient was able to do light labor" (33); "patient suffers from chronic rheumatism; function has been slow in returning; it is not yet complete" (36); "five weeks after injury arm could be elevated to horizontal position" (51), etc.

The prognosis in bilateral shoulder dislocations is influenced by many factors, chief among which should be mentioned, age of the patient and of the dislocation, the patient's occupation, the associated injuries and the treatment instituted. As a rule, the older the patient (36), the longer the period required for recovery. As to the age of the luxation, it is agreed that dislocations call for immediate reduction. Sequelæ are thereby forestalled; nothing is gained by delay. Convalescence is longer in handworkers than in intellectuals; delicate hand movements are late in returning. Associated injuries require appropriate treatment. In some cases full function is not restored before the detached muscles or tuberosities are permanently fixed in their normal place.

Bloodless manipulative methods, supplemented by electro-, mechano- and hydro-therapy give the best results. The two dislocations, right and left, are reduced separately, usually by the same method and at the same sitting. The duration of immobilization varies in different cases: 12 days (31), 5

weeks (36), etc. We are of the opinion that most clinicians err in prolonging complete immobilization beyond two weeks. About the tenth day gentle passive motion and massage and electrical treatment should be instituted.

After an arthrotomy and division of extensive adhesions, even though the bone is replaced to its normal position, some joint-stiffness is to be expected. This is generally compensated for by a movable scapula. The restoration of the rotundity of the shoulder and the absolute relief of pain give much satisfaction to the patient.

After reduction of the dislocations both shoulders are immobilized during the period of repair, the arms fixed in front of the chest by adhesive plaster, bandages, etc., for from two to three weeks. The patient is practically help-less, he cannot feed himself, he cannot dress himself, he cannot attend to many of his other needs; he must be provided with an attendant.

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BOOK REVIEW

A SYSTEM OF SURGERY. Edited by C. C. CHOYCE, F.R.C.S., Director of the Surgical Unit, University College, London, and J. MARTIN BEATTIE, M.D., Professor of Bacteriology, University of Liverpool. In three volumes. Second edition, vol. i, pp. 1013; vol. ii, pp. 1057; vol. iii, pp. 1176. New York, Paul B. Hoeber, 1923.

This work was designed to present to the profession and advanced students a sound and comprehensive treatise on British theory and practice in surgery. The second edition was delayed by the intervention of the Great War, but has now been brought up to date by thorough revision and the rewriting of a number of the articles. Among these articles are very complete sections on X-ray diagnosis, fractures, tetanus, and orthopædic surgery by prominent authors. One hundred and fifty new illustrations, including some fifty new plates, have been added.

The three volumes are compact in arrangement and convenient in size, inviting to easy and frequent use. The illustrations are characteristic and often of excellent diagnostic value. Selected bibliographies are appended to most of the articles.

Volume I is devoted to the general consideration of surgery, including surgical pathology. Several articles covering the latter subject are contributed by the co-editor, Professor Beattie.

Volume II contains articles on regional surgery, including the breast, gastro-intestinal tract, and urinary tract. The section on the breast, by Handley, is very complete, and presents that author's arguments as to the spread of cancer, and his practice as to operation. Sherren, Miles, Grey, Turner, Clogg, and others give well-illustrated articles on gastro-intestinal surgery which are also very complete in the consideration of diagnosis.

Volume III deals with the more special departments of surgery. The female genital tract is concisely treated by Bonney in limited space. The ear, nose, throat, neck and respiratory system are here presented. The nervous system is attractively covered at length by Sherren and Trotter. Bones and joints are very fully treated by Choyce. Fractures and orthopædic surgery, as well as other departments of surgery, are presented at moderate length.

Some portions of the work are less attractive by reason of the free use of fine print to save space. Aside from this, the work makes a good impression, is complete in its scope, and practical in its presentation. It fitly represents British present-day surgery.

RICHARD W. WESTBROOK.